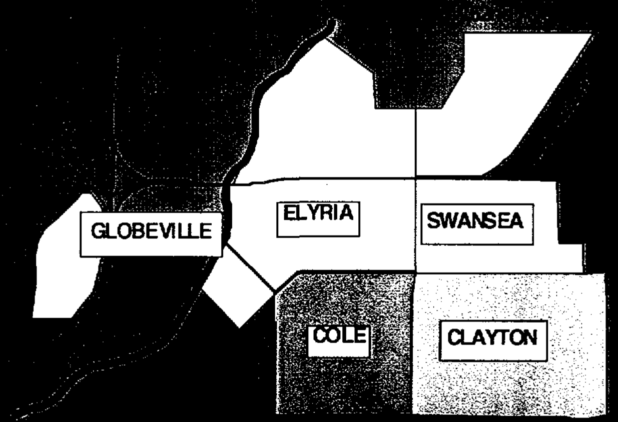
REMEDIAL INVESTIGATION REPORT



Vasquez Boulevard/I-70 Site
Operable Unit 1

489928

FINAL

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Denver, Colorado

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Region VIII

Executive Summary

EXECUTIVE SUMMARY

Site Background

The Vasquez Boulevard and Interstate 70 (VB/I-70) Superfund Site covers an area of approximately four square miles in north-central Denver, Colorado. The site consists of four neighborhoods that are largely residential, including Swansea, Elyria, Clayton, Cole, and the southwest portion of Globeville as presented in Figure ES-1. Most residences at the site are single family dwellings, with some multi-family homes and apartment buildings. The site also contains a number of schools and parks, as well as numerous commercial and industrial properties.

The site came to the attention of the U.S. Environmental Protection Agency (USEPA) following studies directed by the Colorado Department of Public Health and Environment (CDPHE) at the nearby Globe Smelter. These studies had identified elevated concentrations of arsenic and/or lead in residential yards within Globeville, and also extending into the Elyria and Swansea neighborhoods.

The USEPA Emergency Response Program conducted two removal assessment sampling programs, known as Phase I and Phase II, at residential properties within the VB/I-70 study area during 1998. The sampling results at twenty-one properties warranted time critical soil removal based on surface soil concentrations exceeding 450 milligrams per kilogram (mg/kg) of arsenic or 2000 mg/kg of lead. Time critical removal actions were completed by USEPA at eighteen of these properties in 1998. Owners of three properties did not give EPA access to conduct the removal action.

Based on the Phase I and Phase II results the USEPA determined that residential properties within the VB/I-70 site contained arsenic or lead at levels that could present human health concerns over long term exposures. On this basis, the site was proposed for listing and was added to the National Priorities List on July 22, 1999.

Study Area Investigations

A study and two additional investigations were performed between 1998 and 2000 in support of the Baseline Human Health Risk Assessment:

- Physico-Chemical Characterization Study
- Residential Risk-Based Sampling Investigation
- Phase III Field Investigation

The Physico-Chemical Characterization Study conducted analyses on existing Phase I soil samples to generate supplementary data on the physical and chemical characteristics of the surface soils, including the relationship between bulk and fine soil fractions, contaminant phases and particle sizes, and the *in vitro* bioaccessibility of arsenic and lead in site soils. This study concluded that:

- The concentration of arsenic is about 20% higher in the fine fraction than in the bulk fraction of soil. The concentration of cadmium is about 13% higher in the fine fraction than in the bulk fraction. Lead and zinc concentrations are nearly equal in the bulk and fine fractions.
- The primary chemical phase of arsenic in site soils is arsenic trioxide, while lead is present as lead phosphate, lead arsenic oxide and manganese oxide.

- Both arsenic and lead predominantly exist in particles ranging from less than 5 to 49 micrometers in size, although lead-bearing particles are still consistently found in particles 50 to 149 micrometers in size.
- The relative percent bioaccessibility (which is related to, but is not the same as, relative bioavailability) ranges between 3% and 26% for arsenic, and 64% and 83% for lead.

The Residential Risk-Based Sampling Investigation involved collection of soil, dust, paint, tap water, vegetables, and biological samples. Soil samples from five impacted (warranting time critical soil removal) and three unimpacted properties were collected on a five-foot grid and analyzed for arsenic, lead, cadmium, and zinc. At eighteen impacted properties additional environmental sampling was conducted. Where possible, garden soil samples, vegetable samples, and dust samples from living areas and attics were collected and analyzed for arsenic, cadmium, lead, and zinc. At these same homes, paint and tap water samples were collected and analyzed for lead only. Biological samples of blood, hair, and urine were collected from fifteen residents of six impacted properties. The blood samples were analyzed for lead. The urine and hair samples were analyzed for arsenic. The data collected indicate the following:

- Several properties show large variations in surface soil concentrations within the property, and a marked change in arsenic and lead concentration at the property boundary as compared to concentrations on the immediately adjacent property.
- Metals concentrations decrease with increasing depth, and generally are highest in the first two inches of soil.
- Although the data set is too small to draw definite conclusions, the dust sampling results suggest that outdoor soil is not a major determinant of arsenic or lead levels in indoor dust in living areas. There is also no significant correlation for arsenic or lead between the concentration in indoor dust and in attic dust.
- The biomonitoring data do not suggest that exposure levels to lead and arsenic in the individuals tested were significantly greater than normal. Because of the small number of participants, these biomonitoring data must be interpreted with caution.

The Phase III Investigation was planned in early 1999 and implemented between August 1999 and November 2000 to generate data to support reliable risk calculations. The investigation focused on residential surface soil sampling, but also included indoor dust sampling, garden soil and vegetable sampling, and school and park sampling. Soil sampling within alleyways was planned but not implemented due to a lack of unpaved alleys in the study area. The sampling program initially targeted those properties that had not been sampled during the 1998 Phase I or Phase II events, and subsequently encompassed all residential properties. During Phase III, a total of 3007 properties was sampled, including 2989 residential properties, ten schools, seven parks, and one government property. Garden vegetables and soils were sampled at nineteen properties and indoor dust was collected at 75 properties. The investigation succeeded in gaining access to and sampling 76% of all residential properties within the study area.

Residential surface soils (0-2 inches) were characterized by collection of three composites of ten subsamples each and analysis of the bulk fraction for arsenic and lead using an energy dispersive x-ray fluorescence spectrometer. The thirty subsamples were collected from locations equally distributed throughout the yard which were sequentially grouped into composites such that each of the three composites represented an average concentration over the entire yard. Individual grab surface soil samples were later collected at 119 properties where high variability in the composite samples indicated a potential for small areas of relatively high concentration which could potentially result in unacceptable short term risks, i.e., "hot spots." A subset of surface soils was selected for a paired comparison of the concentration of arsenic and lead in the bulk fraction and fine fraction.

Indoor dust samples were collected from the main living areas within 75 homes to provide information on the relationship between indoor dust and yard soils over a wide range of yard soil concentrations. Garden vegetables and co-located garden soils were collected at 19 properties, based on availability of vegetables prior to the fall season hard freeze.

All Phase III analytical results were reviewed and validated against quality control criteria specified in the Quality Assurance Project Plan to confirm that the data quality objectives were met. The Phase III data set documents the following VB/I-70 residential property conditions:

- The majority of properties have low levels of arsenic. Thirty-one percent of the properties have the 95% upper confidence of the mean being either below the method detection limit of 11 mg/kg or near the method detection limit.
- Ninety-one percent of the properties contain mean lead concentrations below the EPA screening level for lead in soil of 400 mg/kg.
- The most frequently observed property mean concentrations of lead are in the range of 100-150 mg/kg.
- Levels of arsenic in the bulk versus fine soil fractions are nearly equal, while lead is slightly higher in the fine fraction.
- Concentrations of arsenic and lead in indoor dust and garden vegetables remain relatively consistent over a wide range of yard soil concentrations.
- Mean arsenic concentrations in surface soils at school and parks range from below the method detection limit of 11 mg/kg to 26 mg/kg. The mean lead concentrations range from 67 mg/kg to 256 mg/kg.

Nature and Extent

The Phase III data were evaluated using statistical methods to characterize the nature and extent of arsenic and lead contamination. A variogram analysis examined the spatial continuity and trends of arsenic and lead. A kriging analysis was performed to identify whether or not spatial patterns are random or continuous. The analyses indicate that elevated arsenic in soils is randomly distributed within the study area, while the lead concentrations tend to decrease with distance from one or more historical smelter locations.

Baseline Human Health Risk Assessment

The risk assessment used data generated under the Phase III Field Investigation. The assessment identified the following potential health risks to residents at the site, assuming that no remedial actions are conducted.

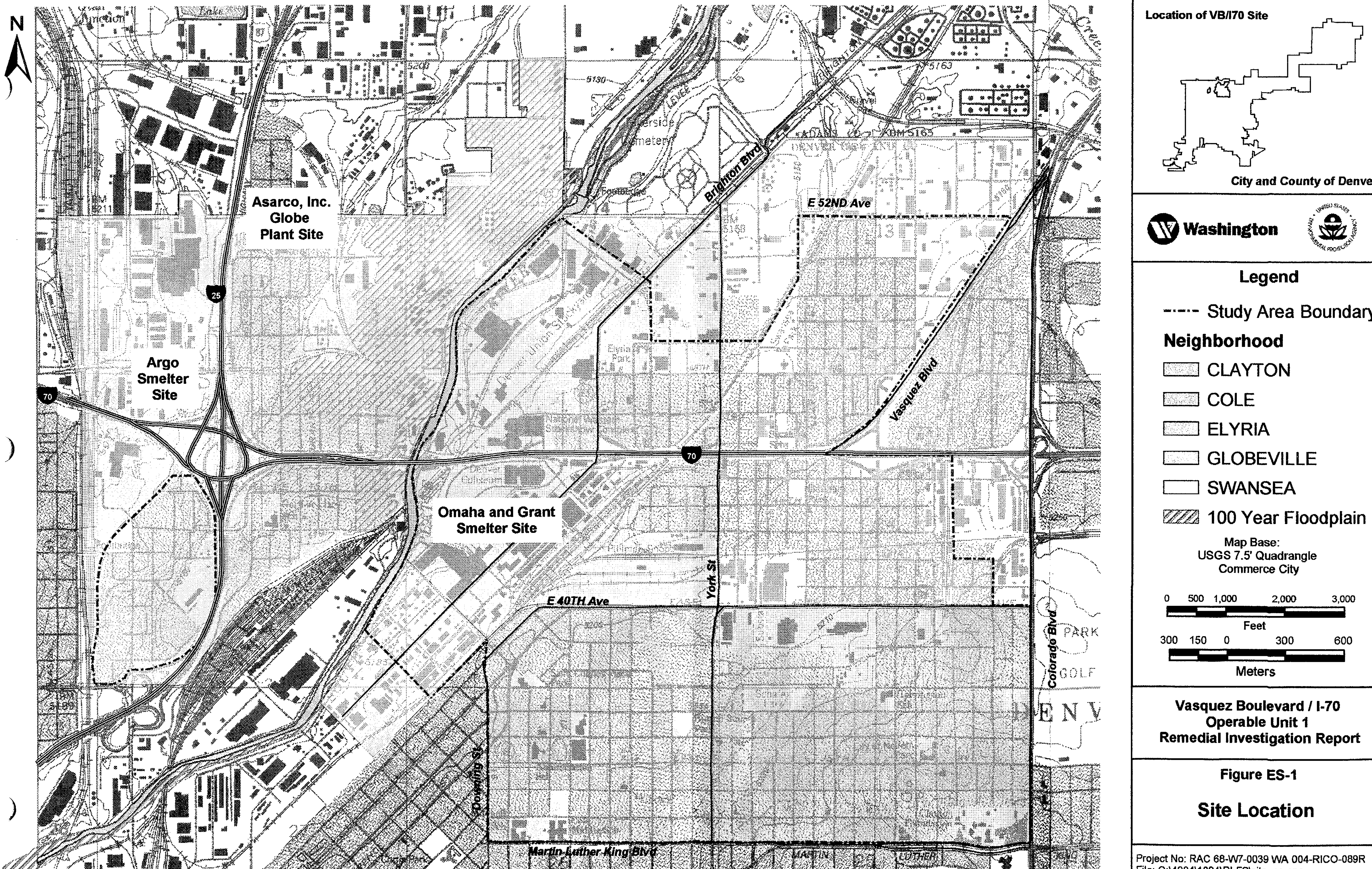
Arsenic

Some residential properties at the VB/I-70 site contain arsenic at concentrations higher than the expected natural levels. Properties with elevated levels of arsenic occur at widely scattered locations across the site, with no clear spatial pattern. In some cases, levels of arsenic in yard soil are sufficiently elevated to pose a reasonable maximum excess lifetime cancer risk that is above a level of 1E-04 (1 in 10,0000). Based on current data, about 2% of all properties fall into this category. Noncancer risks from arsenic are also above a level of human health concern at some properties, mainly at the same locations where cancer risks are above 1E-04.

Theoretical risk calculations suggest that high intake of soil associated with soil pica behavior in children might be of acute noncancer concern at a large number of properties at the site. This finding is judged to be especially uncertain due to the lack of reliable information on the prevalence and frequency of soil pica behavior and the amount of soil ingested in a soil pica occurrence.

Lead

Lead also occurs at elevated levels in soil at some residential properties. Elevations occur in all neighborhoods of the site, but levels tend to be higher on the western part of the site than the eastern part. Using EPA's IEUBK model to evaluate the risk to children, it is estimated that about 45% of residences have levels that exceed USEPA's health-based goal (no more than a 5% chance that a child will have a blood lead value above 10 μg/dL). Of these, many (about 79%) have mean lead concentrations lower than 400 mg/kg (the USEPA screening level for lead in soil). This is mainly because the site-specific relative bioavailability for lead (84%) is higher than the default value (60%).



Washington

Vasquez Boulevard / I-70
Operable Unit 1
Remedial Investigation Report

Figure ES-1

Site Location

Project No: RAC 68-W7-0039 WA 004-RICO-089R
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LIST OF ACRONYMS

ARARs	Applicable or Relevant and Appropriate Requirements
As	Arsenic
BAC	Bioaccessibility
BLUE	Best Linear Unbiased Estimator
CCOD	City and County of Denver
Cd	Cadmium
CDPHE	Colorado Department of Public Health and the Environment
CI	Confidence Interval
CTE	Central Tendency Exposure
CV	Coefficient of Variation
DHA	Denver Housing Authority
DQOs	Data Quality Objectives
EDXRF	Energy Dispersive X-Ray Fluorescence
EMPA	Electron Microprobe Analysis
ft	Feet
GSD	Geometric Standard Deviation
HQ	Hazard Quotient
ICP	Inductively Coupled Plasma Atomic Emission Spectroscopy
IEUBK	Integrated Exposure Uptake Biokinetic Model
IR	Intake Rate
IRIS	Integrated Risk Information System
LEGS	Laboratory for Environmental Geological Studies
μm	Micrometer
μg/dL	Microgram per Deciliter
μg/L	Micrograms per Liter
m	Meter
MDL	Method Detection Limit
mg/kg	Milligram per Kilogram
MTHC	Maximum Theoretical Hot Spot Concentration

NAA	Neutron Activation Analysis
NCP	National Contingency Plan
ND	Nondetect
NIST	National Institute of Standards and Technology
NPL	National Priorities List
OU	Operable Unit
Pb	Lead
ppm	Parts per Million
QA/QC	Quality Assurance / Quality Control
QAPP	Quality Assurance Project Plan
RBA	Relative Bioavailability
RfD	Reference Dose
RI	Remedial Investigation
RL	Reporting Limit
RME	Reasonable Maximum Exposure
SOP	Standard Operating Procedure
sq. ft	Square Feet
TAL	Total Analyte List
UCL	Upper Confidence Limit
UOS	URS Operating Services
USACE	U. S. Army Corps of Engineers
USEPA	U. S. Environmental Protection Agency
VB/I-70	Vasquez Boulevard / Interstate 70
XRF	X-Ray Fluorescence
Zn	Zinc

Section One

1.0 SITE BACKGROUND

The Vasquez Boulevard and I-70 (VB/I-70) Superfund Site is an area of approximately four square miles located in the north-central section of Denver, Colorado. The site consists of four neighborhoods that are largely residential, including Swansea, Elyria, Clayton, Cole, and the southwest portion of Globeville as presented in Figure 1-1. Most residences at the site are single family dwellings, with some multi-family homes and apartment buildings. The site also contains a number of schools and parks, as well as numerous commercial and industrial properties.

The site came to the attention of the U.S. Environmental Protection Agency (USEPA), November 4, 1997, following studies directed by the Colorado Department of Public Health and Environment (CDPHE) at the nearby Globe Smelter (CDPHE 1997). These studies sampled soils from 25 homes in the Elyria and Swansea neighborhoods. Arsenic concentrations ranged from below the detection limit to 1800 parts per million (ppm) and lead concentrations ranged 39 ppm to 754 ppm. As a result, CDPHE asked the USEPA to do a more complete study in the area.

The USEPA Emergency Response program conducted two sampling programs at the site during 1998. A study area initially was defined, extending south to East 38th Avenue, north to East 56th Avenue, east to Colorado Blvd., west to the South Platte River, and included the southwest portion of Globeville. The initial sampling program, known as Phase I, was performed during March and April 1998 and was chiefly to support removal action decisions. A minimum of three grab samples, two surface and one subsurface, were collected from properties where the resident consented access to address the Phase I sampling objective of identifying arsenic, cadmium and lead in residential, school and park soils at levels warranting immediate removal. Samples were collected from locations judged to present a higher potential for exposure relative to other areas of the property (for example, at bare spots within the yard). Samples were analyzed in the field using an x-ray fluorescence spectrometer (XRF) supplemented by USEPA methods analysis at an off-site laboratory. The Phase I sampling identified thirty-seven properties as potential candidates for immediate cleanup based on concentrations of either arsenic or lead in residential surface soils (USEPA 1998j).

As a result of the findings from the Phase I investigation, the USEPA identified a subset of properties requiring confirmation analyses of residential soil. Because samples collected during the Phase I stage were grab samples, confirmation analyses were necessary to determine whether the sample was representative of the yard as a whole. These confirmation analyses were implemented as part of the Phase II investigation. Any residence having a maximum surface soil concentration equal to or greater than 450 ppm for arsenic or 2000 ppm for lead was included in the Phase II investigation. Briefly, selected residences were revisited and a 5-point composite sample was collected in each of the front and back yards. Arsenic and lead levels in these samples were measured. Any property whose yard soil composite sample exceeded the removal action levels for either arsenic or lead was identified for soil removal.

The USEPA Emergency Response proceeded with a Phase II sampling program in July and August 1998, within an expanded study area extending south to East 35th Avenue. Properties not sampled during Phase I were targeted for sampling using the Phase I protocols. Additionally, the thirty-seven candidate properties were resampled using two five-point composite soil samples to determine whether or not mean property concentrations exceeded removal action levels. Twenty-one candidate properties were identified and removals were completed at eighteen properties where permission was granted (USEPA 1998h). A total of 1,393 properties was sampled as part of the Phase I and II programs, including four schools and seven parks. A total of 5,135 individual soil samples was collected. The distribution of maximum lead and arsenic concentrations at the residential properties may be found in Figures 1-2 and 1-3.

Based on the results of the Phase I and Phase II sampling programs, the USEPA determined that residential properties within the VB/I-70 contained concentration of arsenic or lead at levels that could present human health concerns over long term exposures. On this basis, the USEPA proposed the VB/I-70 site for inclusion on the Superfund National Priorities List (NPL) in January 1999, and the site was added to the NPL on July 22, 1999 (FR 1999).

The source of these elevated metals concentrations is not known, but may be related to use of commercial pesticides and/or releases from one or more smelters that have operated in the area. The Argo Smelter operated in Denver from 1878 to 1907 to treat refractory gold ores (CDPHE 1992a). The Omaha and Grant Smelter began operations in Denver from 1882 and produced gold, silver, copper and lead until its closure in 1903 (CDPHE 1998b). The Globe Smelter has been operating in Denver since 1886 when it began as a lead smelter. Additions were made to the arsenic and cadmium recovery circuits beginning in 1905 and yielded increased arsenic and cadmium recovery. After cessation of lead smelting operations in 1919, the Globe Smelter continued to operate as a test lead and litharge refinery and as an arsenic refinery. Arsenic refining operations continued from 1919 to 1926. The facility continued operations as a cadmium refinery between 1927 and 1993. Current operations at the Globe Smelter Facility include treatment of test lead, litharge and small scale production of high purity cadmium (ASARCO 1998a; ASARCO 1998b).

The residential soils are known as the Off-Facility Soils Operable Unit 1 (OU 1) portion of the site, while the Omaha & Grant Smelter and Argo Smelter are identified as On-Facility Soils OU 2 and OU 3, respectively. The Globe Smelter is not part of the VB/I-70 site, but rather is the subject of a separate cleanup being conducted by ASARCO, Inc. and overseen by the CDPHE. The Globe Smelter cleanup, the subject of a 1993 consent decree, has resulted in soil remediation in more than 550 Globeville community properties, as well as ongoing remediation of sources of groundwater contamination on the plant site.

This Remedial Investigation (RI) Report describes the Off-Facility Soils OU 1, including the physical setting, study area investigation, nature and extent of contamination, and the baseline human health risk assessment. This information will be used by the USEPA to manage potential risks and define appropriate remedial actions that protect human health and the environment at this operable unit.

Section Two

2.0 PHYSICAL SETTING

The site is largely flat in topography, sloping gently toward the Platte River, which flows in a northeasterly direction through the site. Other than the Platte River, there are no other major surface water bodies within the site.

The VB/I-70 site parallels and is bounded on the northwest by the South Platte River and on the southwest by Fox Street in Globeville. The study area is bounded on the east by Colorado Boulevard. Northern and southern boundaries for the study area are East 52nd Avenue and Martin Luther King Boulevard.

The climate of the site is typical of Colorado's semiarid eastern plains. Temperatures are moderate throughout the year, with monthly averages ranging from 30° F in January to 73° F in July. Annual rainfall measures 16 inches, 60% of which falls during the spring and summer. The rainiest month is May, with an average rainfall of 2.6 inches. Snowfall totals in the Denver Metro area average 60 inches, with March usually receiving the greatest snowfall (12.5 inches). The Rocky Mountain foothills, about 20 miles west of the site, help create a predominantly southern wind flow across the site, with an annual average velocity of 8.5 mph. Peak winds can reach velocities of 30-50 mph, with the highest winds tending to be from the north-northwest.

The topography of the site varies from approximately 5200 feet above sea level along the northern boundary of the site to about 5140 feet mean sea level in the flood plain. The flood plain is very flat, with a slope of 0.25 percent to the northeast. Drainage in the flood plain is largely controlled by man-made features, such as ditches, roads and sewers. The ground on the terrace portion of the site generally slopes southeast toward the flood plain with a typical grade of about 4 percent. The edge of the terrace drops off fairly steeply to the flood plain from about 5170 feet mean sea level, with a narrow bench at 5150 feet mean sea level. The 100-year flood plain is shown on Figures ES-1, 1-1 and 3.3-1.

<u>*Geology*</u>
Information on the area geology is derived from Robson and Romero (USGS 1981) and the preliminary assessment reports prepared for the smelter site operable units (CDPHE 1992a; CDPHE 1992b).

The site lies to the east of the Front Range of the Southern Rocky Mountains, in the Colorado Piedmont section on the Great Plains. The sedimentary rocks that underlie the region form an asymmetric, north-south trending structural basin known as the Denver Basin, which is more than 13,000 feet thick at its deepest point below the City of Denver. The uppermost bedrock formation below the site is the Denver Formation, consisting of interbedded claystone, shale, and siltstone with silty sandstone lenses. The Denver Formation typically contains approximately 70 percent claystone and shale and 30 percent sandstone and siltstone. The Denver Formation was deposited in the late Cretaceous and early Tertiary periods by rivers and streams flowing in silty and sandy channel deposits within finer-grained claystone and shale beds.

The Denver Formation is underlain by the Arapahoe Formation at a depth of approximately 220 feet below the site. The Arapahoe Formation is the shallowest bedrock aquifer of significant yield in the site area, consisting of about 40 percent conglomerate, sandstone and siltstone, and about 60 percent shale. Underlying the Arapahoe Formation are the Laramie Formation and Fox Hills Sandstone, at depths of approximately 700 feet and 1000 feet, respectively. Below the Fox Hills Sandstone is the extensive Pierre Shale Formation, which is considered to the base of the Denver Basin aquifer system because of its low permeability and thickness of up to 8000 feet.

Most of the bedrock in the Denver area is covered by alluvial and Eolian deposits to depths as great as 100 feet. The oldest alluvial deposit still remaining at the site is Slocum Alluvium, consisting of cobbles, gravel, and clayey sand deposited in rivers that flowed east during the warming period after the Illinoisan glaciation. Subsequent erosion removed most of the Slocum and, at the same time, cut into the Denver Formation bedrock to form the South Platte River drainage system.

There are three distinct physiographic land forms within one mile of the site; an upland surface west and east of the South Platte River, the flood plain of the river, and a terrace escarpment. The soils on the upland are the Vona sandy loam, the Truckton loamy sand, Truckton sandy loam and the Nunn clay loam. The Vona and Truckton series are deep, well to excessively drained coarse-textured soils. The Nunn clay loam is a deep, well drained clayey soil.

The soils of the flood plain of the South Platte River are mapped as loamy alluvial to moderately wet and sandy alluvial. These soils are formed on loamy or sandy and/or gravelly stratified alluvial materials. The upland is separated from the flood plain by an escarpment mapped as gravelly shale outcrop. These escarpments have steep slopes and very shallow soils over clay, gravel, shale and sandstone. The residential soils are generally sandy to clayey loams, organic rich, and relatively uniform.

Hydrogeology

Information on the area geology is derived from Robson and Romero (USGS 1981) and the preliminary assessment reports prepared for the smelter site operable units (CDPHE 1992a; CDPHE 1992b).

The two uppermost principal ground water systems that underlie the area are the upper shallow alluvial aquifer and the deeper bedrock Denver Aquifer. The shallow alluvial aquifer is unconfined and generally comprised of sand and gravel that contains various amounts of clay and silt. In some areas these coarse-grained materials grade to a finer material, and clay and silty materials predominate. The rate of ground water movement through these deposits is governed principally by the variable nature of these deposits. Due to the highly weathered nature of the upper part of the bedrock aquifer, it is likely that this layer belongs hydrogeologically with the overlying unconsolidated alluvial deposits. That is, due to the higher hydraulic conductivity of the weathered Denver Formation than the underlying unweathered bedrock, ground water will preferentially flow horizontally in the alluvial/weathered unit rather than downward.

The depth to ground water ranges from 10 to 20 feet below the ground surface in areas of the site nearest the South Platte River. Generally, the direction of ground water is from the southeast to the northwest toward the South Platte River at approximately 20 to 200 feet/year, then toward the northeast parallel to river flow.

Section Three

3.0 STUDY AREA INVESTIGATION

In 1998, USEPA Region VIII convened a Working Group to provide a discussion forum for community members, State and local governmental agencies and other interested parties to provide input to the USEPA on all aspects of the remedial investigation and feasibility study for the VB/I-70 site. The USEPA Region VIII has worked in cooperation with VB/I-70 Working Group, currently comprised of representatives of the local community, the City and County of Denver (CCOD), CDPHE, ATSDR and ASARCO, to investigate surface soil contamination and the potential for human exposure at the VB/I-70 site. Several studies have been conducted at the VB/I-70 site since 1998, including the Phase I and Phase II investigations, Physico-Chemical Characterization of Soils, Residential Risk-Based Sampling, and the Phase III Investigation. The results of the Phase I and II Removal Site Assessment programs are compiled in separate Sampling Analysis Reports (USEPA 1998d and 1998h). Data collected during these programs have been used for subsequent studies, as referenced in this RI report, however, the samples were collected primarily to support removal action decisions. The three studies used as the basis for the baseline human health risk assessment are described in this section: the Physico-Chemical Characterization of Soils; the Residential Risk-Based Sampling; and the Phase III Investigation.

3.1 Physico-Chemical Characterization of Soils

The Physico-Chemical Characterization of Soils utilized the 2400 soil samples collected in 1998 as part of the Phase I investigation surface soil results. Five percent or a total of 120 of these samples was selected for the Physico-Chemical Characterization Study.

The Phase I investigation provided information on contaminant concentrations in bulk soil fractions within the VB/I-70 site. However, to better characterize potential exposure and risk at the site, supplementary data on the physical and chemical characteristics of the surface soils were required. The Physico-Chemical Characterization of Soils was performed to collect the necessary supplementary data. The primary components of this study were as follows:

- Determine the relationship between two soil fractions: bulk soils (sieved to <2 mm) and fines (sieved to <250 μm).
- Determine the phases and particle sizes of lead and arsenic contributing to the total lead and arsenic detected in the fines fraction of surface soils.
- Estimate the fraction of arsenic and lead that is bioaccessible (potentially available for absorption) using an *in vitro* bioaccessibility test.

3.1.1 Analytical Procedures

The 120 archived soil samples were transferred under chain-of-custody from the Phase I contractor to the Laboratory for Environmental Geological Studies (LEGS) at the University of Colorado. All analyses performed by the University of Colorado on behalf of USEPA were performed in accordance with the Quality Assurance Project Plan (QAPP) prepared and approved for this investigation (USEPA 1998k). The QAPP required quantification of concentrations for four metals: arsenic, cadmium, lead and zinc. Geochemical speciation, particle size distribution analysis, and *in* *vitro* bioaccessibility tests were stipulated for lead and arsenic only. The following procedures or analyses were performed at LEGS:

- Soils were air dried and then sieved into two fractions (bulk and fines) in preparation for chemical testing. The soil fraction <2 mm was defined as the bulk fraction. The fraction <250 μm was defined as the fine fraction.
- Each bulk and fines fraction was analyzed via x-ray fluorescence (XRF) for quantification of arsenic, cadmium, lead and zinc concentrations.
- A portion (22 samples) of surface soil samples submitted to the laboratory was analyzed to determine the particle size and phase of arsenic and lead contributing to the lead and arsenic found in the fines fraction of surface soils.
- A portion (10 samples) of samples submitted for speciation analysis was also evaluated for lead and arsenic bioaccessibility using an *in vitro* bioaccessibility test.

The procedures and analyses listed above were performed in accordance with standard operating procedures (SOPs) included as part of an approved quality assurance project plan for the VB/I-70 site (USEPA 1998k). The results are summarized in the following sections. A summary of the data is contained in Appendix B.

3.1.2 Bulk Soils and Fines Fraction

The concentrations of metal present in the bulk and fine fractions were compared using linear regression analysis and the resulting graphs are presented in Figures 3.1-1a through 3.1-1d. The slope and intercept values and their respective 90% confidence intervals (CI) are presented in the table below.

Table 3.1-1 Linear Regression Values for 1998 Bulk Samples and Fines

	Slope			Intercept		
Chemical	Best	90% CI	P value	Best	90% CI	P value
Arsenic	1.17	1.11 to 1.23	<0.001	36	-0.4 to 72	0.052
Cadmium	1.13	1.04 to 1.22	<0.001	0	-0.8 to 0.7	0.941
Lead	0.96	0.92 to 0.99	<0.001	56	33 to 78	<0.001
Zinc	0.99	0.95 to 1.03	<0.001	18	4 to 32	0.013

As seen above, the slope of all of the lines is near one, and the intercepts are near zero. This means that there is little or no authentic difference in concentrations in any of the four chemicals between the bulk fraction and the fines fraction. However, the intercepts of two chemicals (lead and zinc) are significantly greater than zero and the intercept for arsenic is nearly significant. This suggests that there may be a small negative bias in estimation of bulk concentrations for lead and zinc and possibly arsenic. That is, the concentrations of metals in the bulk samples will tend to slightly underestimate the concentration in the fines at low concentration values, based on the regression analysis. The 90% confidence intervals shown in Figures 3.1-1a through 3.1-1d and Table 3.1-1 reflect uncertainty in the best-fit linear regression line through the data. These confidence bounds were calculated using a commercial statistical package called TableCurve. The bounds of the confidence interval around the best fit straight line do not imply that 90% of all data points must lie within the confidence interval. No data points were removed as outliers in the calculation of the regression line for Figures 3.1-1a through 3.1-1d.

Quality Control Samples
Twenty percent of samples (both bulk and fine fractions) analyzed by LEGS were also submitted to a second laboratory for confirmation analysis. This confirmation testing was performed via inductively coupled argon plasma (ICP). Appendix A1 contains a graphical comparison for lead and arsenic. As seen, in all four cases, the slope of the best fit straight line through the inter-laboratory pairs is about 0.7, indicating that XRF values are about 30% higher than those of the standard analytical procedure. A difference of this type is common if some of the metals present in soils that are not readily extracted from the soil in acid. This difference in analytical methods notwithstanding, the strong correlation (R^2>0.95) indicates that there is good inter-laboratory agreement further supporting the conclusion that there is little difference between the bulk and fine fractions. Further investigation in the basis for the difference between the XRF and ICP results was initiated by the USEPA.

3.1.3 Speciation

About 20 percent (or 22) of the fines fraction of samples analyzed by LEGS for arsenic, cadmium, lead and zinc by XRF was also evaluated for geochemical speciation by electron microprobe analysis (EMPA). Figures 3.1-2a and 3.1-2b show the distribution of each phase (chemical form) as a function of the total lead or arsenic present in the soil. As seen, nearly all arsenic mass present in the soil samples is present as a single phase: arsenic trioxide (As_2O_3). By contrast with arsenic, a number of distinct phases are contributing to the lead mass onsite: lead phosphate, lead arsenic oxide and manganese oxide.

3.1.4 Particle Size Distribution

Particle size distributions were evaluated for the same set of samples for which EMPA speciation analysis was performed. Figures 3.1-3a to 3.1-3b show the respective arsenic and lead masses by particle phase as a function of the total arsenic or lead present in the fines fraction of the soil. As seen, the arsenic-bearing particles contained in the surface soils are predominately found in particles between <5 and 49 μm in size. This appeared to contradict the conclusion that there is little difference in arsenic concentration between the bulk and fine fractions of soil. One explanation is that some of the fine grains of arsenic exist in association with larger particles that did not pass the 250 μm sieve. The majority of the lead mass found in the surface soils is also found in particles between <5 and 49 μm in size, although lead-bearing particles are still consistently found in particles 50 to 149 μm in size.

3.1.5 In Vitro Bioaccessibility

About ten percent (or 10) of the fines fraction samples analyzed by LEGS for arsenic, cadmium, lead and zinc by XRF were also tested for bioaccessibility (BAC) of lead and arsenic using an *in vitro* bioaccessibility test. The results are summarized in Table 3.1-2. As seen, the relative percent bioaccessibility ranges between 3% and 26% for arsenic and 64% and 83% for lead.

Table 3.1-2 Relative Percent Bioaccessibility

Sample Name	Arsenic (ppm)	Arsenic Bioaccessibility (%)	Lead (ppm)	Lead Bioaccessibility (%)
ND-98-022	130	7	96	76
ND-98-106	973	18	682	74
ND-98-117	1907	14	423	78
ND-98-056	234	8	135	83
ND-98-118	1191	26	1434	83
ND-98-119	2690	3	691	64
ND-98-080	504	23	586	79
ND-98-102	704	13	475	76
ND-98-113	1409	3	362	64
ND-98-027	183	11	349	68

It is important to note that the relative percent bioaccessibility is not equal to the Relative Bioavailability (RBA) *in vivo*. Bioaccessibility is the measure of the percent of lead or arsenic that is solubilized under specific test conditions that are meant to imitate gastric conditions. Relative bioavailabiltiy is the fraction of an ingested dose of the lead or arsenic that is absorbed into the systemic circulation, expressed as a percent of the amount absorbed from an equal dose of some readily soluble reference form of the chemical. Current investigations have shown a reasonable correlation between *in vivo* RBA and *in vitro* bioaccessibility for lead (Drexler 1997; Ruby, et al. 1996; Drexler, et al. 2001). However, the comparison between *in vivo* RBA and *in vitro* bioaccessibility for arsenic is not well established. Thus, all *in vitro* BAC results (especially those for arsenic) must be interpreted and used with caution.

3.2 Residential Risk-Based Sampling Investigation

The USEPA implemented a sampling and analysis program in the Summer and Fall of 1998 to collect information to support more detailed risk calculations. Three objectives were defined for this study, as detailed in the Project Plan for the Risk-Based Sampling Stage I Investigation (USEPA 1998a):

1) Characterize the nature and extent of arsenic (As), cadmium (Cd), lead (Pb) and zinc (Zn) contamination within selected residential yards by performing high-density ("intensive") sampling of surface soils.

2) Quantify the levels of As, Cd, Pb and Zn (where applicable) in the following environmental media at residences identified for soil removal action[1]:

Table 3.2-1 Risk-Based Sampling Target Analytes by Media

Environmental Media	Target Analytes
Indoor Household Dust	As, Cd, Pb, Zn
Attic Dust	As, Cd, Pb, Zn
Tap Water	Pb
Exterior and Interior Paint	Pb
Garden Vegetables	As, Cd, Pb, Zn
Surface Soil Samples Co-located with Garden Vegetables	As, Cd, Pb, Zn

3) Estimate the extent to which residents at properties identified for soil removal action were (prior to the removal action) exposed to arsenic and lead by implementing a voluntary biomonitoring program to quantify levels of arsenic in hair and urine and levels of lead in blood. The details of each activity and the results are provided in the subsequent sections.

3.2.1 Intensive Grid Sampling Investigation

This section summarizes the activities and results of the intensive grid sampling event which took place during the Summer and Fall of 1998.

As described in Section 1, the Phase I and II Surface Soil Investigations (Phase I and II) indicated that elevated levels of arsenic and lead existed in yard soils at some residences. However, no discernable pattern for the extent of the metals contamination was apparent. That is, marked differences in metals concentrations were noted even among grab samples collected at a single residence. An intensive surface soil sampling program was implemented at selected residences located within site boundaries to further investigate the variability of contamination within a yard.

The intensive sampling program was designed to determine if the variability in metals concentrations in a yard were random or whether patterns in concentrations could be observed. This objective was accomplished by selecting a representative subset of residences within the site and collecting a large number of grab surface soil samples from the property. A total of eight residences was identified for intensive grid sampling. These residences were selected based upon the results of Phase I and II. Five of the eight locations were identified as "impacted" and consisted of the five residences having the greatest arsenic concentrations and scheduled to undergo removal action. The remaining

[1] USEPA Region VIII identified 18 residences for soil removal. These residences reported mean yard soil concentrations above 450 ppm for arsenic and/or 2000 ppm for lead (USEPA 1998b).

three residences were identified as "unimpacted" because the maximum arsenic concentrations measured at these properties during Phase I were below the removal action level of 450 parts per million (ppm). The unimpacted residences were selected by first stratifying all unimpacted residences in the study area into three arsenic concentration ranges: <45-100 ppm, 100-200 ppm and 200-400 ppm. A single residence was then randomly chosen from each range. All concentration values used to identify prospective residences were the maximum arsenic concentration value reported at each residence.

3.2.1.1 Description of Activities

The field activities for the intensive grid surface soil sampling were divided into two stages and each stage was implemented by a different contractor. The first stage was conducted by URS Operating Services (UOS) in Summer 1998. UOS collected soil samples for all impacted residences. In the Fall of 1998, the U.S. Army Corps of Engineers (USACE) conducted field activities for the second stage. The USACE contracted with Roy F. Weston (WESTON) to collect all samples for the unimpacted residences.

A 5'x5' grid was superimposed over the entire yard area of each of the eight residences (termed "focal" residence). Whenever access was permitted, samples at residences adjacent to the focal residences (termed "adjacent"residences) were also collected. However, the entire yard area was not sampled at adjacent residences. Rather, surface soils at adjacent residences were usually collected at locations contiguous to the focal property on a 5'x5' grid up to about 15 feet away from the focal property. Surficial soil samples (0-2" depth) were collected approximately at each node of the grid. If a sample could not be collected at the grid node due to the presence of an obstruction, but could be collected if the point was offset slightly, samples were collected and the revised sample location was identified on field maps. If a sample could not be collected at the grid node due to the presence of a structure (e.g. house, shed, driveway, etc.), and the sample location could not be offset slightly, then no sample was collected. All surface soil samples were containerized, labeled and transported to the analytical laboratory in accordance with the project plan.

In addition to collection of surface soil samples, a minimum of four soil core samples was collected at each focal residence. At a minimum, two 12-inch soil cores each were collected from the front and back yards of the eight focal properties. Each core sample was divided into five 2 inch intervals (2-4", 4-6", 6-8", 8-10" and 10-12") and each interval was packaged separately. The 0-2" interval was retained as the surface soil sample for that sample location and was handled as described above. All core samples were containerized, labeled and transported to the analytical laboratory in accordance with the project plan (USEPA 1998a).

CAD drawings depicting the approximate surface and core sample locations for each of the eight focal residences and the respective adjacent residences are provided in Appendix C. These drawings were prepared by the contractors responsible for the field activities (UOS and WESTON). It is important to note that sample locations were determined using simple linear measurements (e.g. tape measure) rather than more accurate forms of measurement (e.g. Global Positioning System); therefore all sample locations presented in Appendix C are approximations only.

All surface and core soil samples were submitted to the University of Colorado for sample preparation and analysis. Samples were dried and sieved to the prescribed particle size (<250 μm) in accordance with the study design and then analyzed for arsenic, cadmium, lead and zinc using XRF methodology. Ten percent of samples analyzed by XRF were submitted to contract laboratories for confirmation analysis. A portion (split) of the prepared sample was delivered to the contract laboratory under chain-of-custody and measured for the same four metals using ICP or ICP-MS instrumentation.

3.2.1.2 Discussion of Results

Results of the intensive grid surface soil and core sampling program are presented in a number of ways. First, tables summarizing all raw analytical results for surface and core soil samples are provided in Appendix D. However, as mentioned previously, the objective for this phase of the investigation was to determine the extent of metals contamination and to discern whether spatial patterns are evident. Therefore, several different types of maps have been prepared in order to facilitate this evaluation.

2-D Schematics for Arsenic, Cadmium, Lead and Zinc

Simple schematics of each focal property and its associated adjacent properties are presented in Appendix E. Approximate sample locations are identified with a colored circle coded to indicate the concentration level observed at the sample location. The color codes used to reflect concentration ranges were selected as follows:

Table 3.2-2 Intensive Grid Sampling Map Coding

Analyte	Color	Range (ppm)	Notes
Arsenic	Green Blue Yellow Orange Red	<= 70 71-150 151-450 451-1000 >1000	<70 ppm was considered to require no action at the nearby Globe Site. 450 ppm was removal level at this site
Lead	Green Blue Yellow Orange Red	<= 400 401-1000 1001-1500 1501-2000 > 2000	400 ppm: EPA's default residential screening level 2000 ppm was removal level at this site
Cadmium	Green Blue Yellow Orange Red	<= 78 79-156 157-234 235-312 > 312	Risk-based concentration (HQ= 1) from Region III[1]
Zinc	Green Blue Yellow Orange Red	<= 23000 23001-46000 46001-69000 69001-92000 > 92000	Risk-based concentration (HQ= 1) from Region III[1]

[1]USEPA, 1998e

It is important to note that the use of these color codes and concentration ranges for presentation of data does not imply site-specific benchmark values for VB/I-70. Rather, these values are merely used to present the data in a convenient way.

Inspection of these figures reveals that there can be large variations in the concentration of both arsenic and lead over rather small distances, both across property lines and within a property. Areas where a sharp change in concentration across several samples was noted are termed "boundary effects." Boundary effects between adjacent residences are observed at Locations 1, 2 and 5 for both arsenic and lead. Boundary effects at adjacent regions of a single residence are observed at Locations 1, 2 and 8 for arsenic and Locations 1 and 2 for lead. Boundary effects are not observed for cadmium and zinc at any of the eight residences.

Also included in these figures are depth profiles for each core sample collected at a residence. Metals concentrations for each 2-inch interval are presented. Core samples are identified in the schematic as an open hole and the X-Y coordinate corresponding to that sample location is identified on the profile graph. Although the absolute concentration of each metal varies considerably, concentrations of all target metals (As, Cd, Pb and Zn) tend to decrease with increasing depth. Therefore, metals concentrations at the surface appear greatest.

3-D Surface Plots and 2-D Contour Maps for Arsenic and Lead

Surface plots can often provide a better perspective of the levels of metals observed at a site because the actual magnitude of the metals concentration is provided rather than a broad concentration range (as was used in the 2-D schematics). Surface plots were prepared for arsenic and lead for all eight residences (Appendices F1 and F2), but were not prepared for cadmium and zinc since metal concentrations were below their respective screening-level values. Metal concentrations were plotted on the z-axis giving three-dimensionality to arsenic and lead levels at each property. Although peaks in metals concentration are evident, the boundary effects discussed previously are still distinct. Note that the scale for these figures has been restricted to a maximum of 6000 ppm for arsenic. This was done to clearly depict changes in concentration at reasonable intervals (approximately 375 ppm.) Therefore, the maximum peak depicts arsenic concentrations that are greater than or equal to 6000 ppm. A table in Appendix F3 summarizes the list of samples affected by this.

These surface plots were also used to prepare contour maps for arsenic and lead (Appendix G). These maps present the plan view of the surface plot allowing a clear view of concentration gradients and sampling locations.

Quality Assurance/Quality Control

Although the two contractors submitted confirmation samples to different analytical laboratories, both laboratories show a significant difference in measured concentrations for all four metals between XRF and ICP instrumentation. As presented in Appendix A2, the slopes of the best fit straight line through the inter-laboratory pairs are between 0.5 and 0.7, indicating that XRF values are about 30-50% higher than the same samples measured using the USEPA methodology. These findings are similar to those reported for the Physico-Chemical Characterization of Soil in Appendix A1.

Blind Quality Control Standards
In order to test the accuracy of metals analysis at the commercial laboratory, blind quality control (QC) standards were inserted into the sample stream with the split (confirmation) samples. The same set of standards was submitted to each laboratory, with one exception. An additional standard (NIST 2604) was provided to the laboratory performing the analysis of soils for the unimpacted residences. As seen in Appendix A2 analytical results for arsenic were accurate over the range of concentrations submitted both within and between labs, although a trend for decreasing accuracy with decreasing concentrations is observed. In general, this trend is observed for the cadmium, lead and zinc as well. At high lead concentrations, the results for unimpacted properties appear to be biased low.

3.2.1.3 TAL Metals Analyses
A total of ten samples, two randomly chosen from each of five impacted properties, was sieved to the fine fraction and submitted for analysis of total target analyte list (TAL) metals. The results of the analyses are presented in Table 3.2-3.

Table 3.2-3 Total Target Analyte List Metals Concentrations

Sample ID	ALUMINUM		ARSENIC		BERYLLIUM		CALCIUM		CADMIUM		COPPER		IRON		POTASSIUM	
	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL
ND-98-253	9770	5	1360	10	0.83	0.2	8830	10	11.1	0.5	71.4	2	17300	10	3080	500
ND-98-782	7870	25	8890	50	ND	1	6540	50	12.5	2.5	42.5	10	14500	10	2440	500
ND-98-292	6650	5	151	10	0.56	0.2	2690	10	4.4	0.5	19.7	2	12400	10	1960	500
ND-98-640	7610	5	127	10	0.68	0.2	2150	10	1.6	0.5	28.5	2	15900	10	2410	500
ND-98-627	8730	5	584	10	0.73	0.2	5720	10	7.6	0.5	40.3	2	16600	10	1980	500
ND-98-549	9520	5	1990	10	0.74	0.2	7540	10	7.1	0.5	30.7	2	16200	10	2640	500
ND-98-1302	9950	25	9940	100	ND	1	9960	50	19.0	2.5	47.4	10	16400	10	1800	500
ND-98-1273	11200	5	1040	10	1.1	0.2	8110	10	14.2	0.5	52.7	2	14600	10	1650	500
ND-98-336	8370	5	1590	10	0.69	0.2	4000	10	13.7	0.5	43.6	2	14600	10	1650	500
ND-98-245	12100	5	178	10	1.0	0.2	4290	10	4.0	0.5	36.3	2	19400	10	4320	500

Sample ID	MAGNESIUM		SODIUM		LEAD		ANTIMONY		ZINC		MERCURY		SILVER		BARIUM	
	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL
ND-98-253	2930	5	ND	500	1520	5	8.1	6	410	2	2.9	0.16	0.58	0.01	339	0.5
ND-98-782	2670	25	ND	500	1870	25	42.2	30	278	10	11.4	0.99	0.44	0.01	155	0.1
ND-98-292	2020	5	ND	500	219	5	ND	6	151	2	0.23	0.033	0.3	0.01	124	0.1
ND-98-640	2100	5	ND	500	171	5	ND	6	86.1	2	0.15	0.033	0.79	0.01	125	0.1
ND-98-627	3150	5	ND	500	1230	5	ND	6	261	2	0.93	0.16	1.1	0.01	157	0.1
ND-98-549	2910	5	648	500	743	5	10.7	6	3680	2	6.6	0.99	0.80	0.01	189	0.1
ND-98-1302	3390	25	ND	500	3550	25	54.4	30	1060	10	8.7	0.38	0.63	0.01	278	0.5
ND-98-1273	3100	5	ND	500	1750	5	ND	6	433	2	1.1	0.16	0.85	0.01	330	0.5
ND-98-336	2510	5	ND	500	1040	5	14.2	6	279	2	1.8	0.16	0.82	0.01	121	0.1
ND-98-245	3320	5	99.5	500	367	5	ND	6	204	2	1.0	0.2	0.80	0.01	252	0.5

Sample ID	COBALT		CHROMIUM		MANGANESE		NICKEL		SELENIUM		THALLIUM		VANADIUM	
	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL	TOTAL	RL
ND-98-253	5.6	0.1	16.7	0.1	325	0.1	10.4	0.1	1.5	0.5	0.49	0.1	16.5	0.5
ND-98-782	3.8	0.1	21.0	0.1	186	0.1	9.7	0.1	4.5	0.5	0.63	0.1	20.9	0.5
ND-98-292	3.5	0.1	22.8	0.1	170	0.1	7.1	0.1	0.65	0.5	0.31	0.1	13.4	0.5
ND-98-640	3.8	0.1	8.6	0.1	188	0.1	6.7	0.1	ND	0.5	0.20	0.1	13.5	0.5
ND-98-627	4.7	0.1	55.5	0.1	302	0.1	9.8	0.1	0.92	0.5	0.43	0.1	15.3	0.5
ND-98-549	5.4	0.1	21.0	0.1	346	0.1	9.0	0.1	2.6	0.5	0.33	0.1	15.7	0.5
ND-98-1302	4.9	0.1	36.4	0.1	320	0.1	12.1	0.1	5.2	0.5	0.68	0.1	15.3	0.5
ND-98-1273	5.7	0.1	21.4	0.1	364	0.1	11.7	0.1	1.4	0.5	0.48	0.1	18.8	0.5
ND-98-336	4.3	0.1	47.8	0.1	338	0.1	10.4	0.1	1.7	0.5	0.63	0.1	15.2	0.5
ND-98-245	6.8	0.1	13.8	0.1	396	0.1	11.2	0.1	ND	0.5	0.33	0.1	18.6	0.5

All results in mg/kg
ND: Not Detected
RL: Reporting Limit

3.2.2 Environmental Sampling and Biomonitoring at Removal Properties

This section summarizes environmental sampling and biomonitoring activities that were implemented during the Fall of 1998 at residences identified for yard soil removal action.

As a result of the findings from the Phase I investigation, the USEPA identified a subset of properties requiring confirmation analyses of residential soil. Because samples collected during the Phase I stage were grab samples, confirmation analyses were necessary to determine whether the sample was representative of the yard as a whole. These confirmation analyses were implemented as part of the Phase II investigation. Any residence having a maximum surface soil concentration equal to or greater than 450 ppm for arsenic or 2000 ppm for lead was included in the Phase II investigation. Briefly, selected residences were revisited and a 5-point composite sample was collected in each of the front and back yards. Arsenic and lead levels in these samples were measured. Any property whose yard soil composite sample exceeded the removal action levels for either arsenic or lead was identified for soil removal.

Because the properties selected for soil removal are locations where exposures are potentially high, it was considered to be important to obtain as much data as possible about the potential risks associated with exposure to these contaminated soils before the removal occurred. Therefore, an environmental sampling program was implemented at all properties where removal actions were expected. Additionally, a voluntary biomonitoring program was implemented in order to assess the exposure levels of individuals residing in these homes.

3.2.2.1 Environmental Sampling Program

The environmental sampling program was designed to quantify the levels of arsenic, cadmium, lead, and zinc present in indoor household and attic dust, garden vegetables and surface soil samples co-located with garden vegetables, tap water (lead only), and exterior and interior paint (lead only). Surface soil data for these properties were reported by UOS as part of Phase II report (USEPA 1998h).

A total of 21 residences was identified in the Phase II investigation for soil removal. Of these, environmental samples were collected from 18 of the residences. Owners of the three remaining properties declined to participate in both the removal action and the environmental sampling. All environmental sampling activities described in this section were implemented by the USACE. The USACE contracted with Roy F. Weston (WESTON) to collect all environmental samples. Samples prescribed in the project plan were collected in accordance with the project plan (USEPA 1998a), except as described in Table 3.2-4.

Table 3.2-4 Summary of Environmental Sampling at Removal Properties

Residence Code	Living Area Dust Sample (sq. ft sampled)	Attic Dust Sample (sq. ft sampled)	Water Sample	Vegetables	Deviation from Project Plan[a]
A	Y	Y	Y	N	
B	Y (3)	Y (2)	Y	N	
C	Y (2)	N	N	N	Tenant claimed there was no attic access, not very cooperative. We have checked back 3 times, door is always open, but tenant doesn't answer. We have not retrieved water sample bottles
D	Y (2)	Y (3)	Y	N	
E	Y (2)	Y (2)	Y	N	
F	Y (2.5)	Y (12 Linear + 1 sq.)	Y	N	
G	Y (2)	Y (12 Linear)	D	N	Owner filled initial bottle in the morning, but didn't fill the 5 minute bottle. We arrived to pick bottles up, had him fill the other bottle after running tap 5 minutes.
H	Y (2)	N	D	N	Attic access blocked by full closet- Tenant supposedly moving weekend of Oct. 10. Returned 2 days straight for water samples, which had not been taken. Tenant would not let us in house, but let us fill bottles at an outside tap.
I	Y	D (1)	Y	N	Attic had been converted to a bedroom, so a dusty corner of the bedroom was sampled.
J	Y (17)	Y (4)	Y	Y	House was very clean. Took 17 sq. ft. to obtain 0.5g living room sample.
K	D (22)	D (2)	Y	N	After vacuuming 22 sq. ft., only recovered 0.2g of dust. No attic access. Sampled basement in place of attic, and because it was the only place there was dust.
L	Y (2)	D (9)	N	N	No attic access. Took substitute from basement.
M	N (12)	D (10)	N	N	Vacuumed 12 sq. ft. in living room and recovered no sample. Has attic access, but door would be destroyed in process of opening it. Substitution for attic sample was taken from top of cabinets in kitchen.
N	D (20)	Y (3)	Y	N	Vacuumed 20 sq ft, only recovered 0.2g of dust.
O	Y (3)	Y	Y	N	
P	Y	Y	Y	N	

D = Deviation

Y= Sample Collected

N= Sample Not Collected

a= USEPA, 1998a

Indoor Household and Attic Dust

Two types of indoor dust were collected at each residence: household dust and attic dust. The household dust estimates residential dust exposure whereas attic dust provides an estimate of historic deposition of dust.

Dust samples were collected from surfaces using a low-volume vacuum method in accord with protocols outlined in the project plan. In brief, samples were collected by placing a template of known area at the location to be sampled and then vacuuming the area inside of the template until a sample mass of approximately 1 gram was obtained. Household dust was collected in the living area of each residence (e.g. bedroom, kitchen, living room, etc.) whereas attic dust samples were obtained in attics and lofts. Household dust samples were composited from samples collected in each of the bedroom, kitchen and living space. A single template from each of three rooms was prescribed. Larger quantities of dust were anticipated in the attic; therefore, a single template was prescribed for attic dust collection.

However, collection of a sufficient mass of dust (1 gram) was problematic. If the mass of sample collected from a single template was inadequate, additional templates were placed and vacuumed until the appropriate sample size was obtained. If several templates were placed but yielded insufficient sample mass, this information was noted. Additionally, there are two cases where attic dust samples could not be collected. In these cases samples were collected from the basement. The analytical results for these samples are provided in Appendix H1, however, these samples are not included in statistical evaluations.

All dust samples were containerized, labeled and transported to the University of Colorado for sample preparation and analysis in accordance with project requirements. Samples were sieved to remove particles such as lint or hair. All samples were then analyzed for four metals: arsenic (As), cadmium (Cd), lead (Pb) and zinc (Zn) using XRF.

Due to limited sample size, chemical analysis of the dust samples was problematic and several samples could not be analyzed. Additionally, because of sample size limitations, analysis via the prescribed method (XRF) was not always possible. Therefore, all dust samples were prepared using a boric acid digestion and analyzed via ICP. The summary statistics are shown in Table 3.2-5.

Table 3.2-5 Summary Statistics for Attic and Household Dust

Attic Dust

Analyte	ICP (ppm)					XRF (ppm)				
	N	DF	Mean	Min	Max	N	DF	Mean	Min	Max
As	8	2/8	58	53	62	9	7/8	230	53	499
Pb	8	8/8	1156	253	2900	9	9/9	1414	231	4106
Cd	8	8/8	58	21	173	9	9/9	56	7	275
Zn	8	8/8	2374	443	7218	9	9/9	2384	427	4538

Household Dust

Analyte	ICP (ppm)					XRF (ppm)				
	N	DF	Mean	Min	Max	N	DF	Mean	Min	Max
As	8	0/8	--	--	--	15	14/15	107	45	172
Pb	8	8/8	318	121	625	15	15/15	243	67	1145
Cd	8	8/8	18	5	44	15	15/15	18	6	39
Zn	8	8/8	661	254	1121	15	15/15	984	318	2002

N = number of samples
DF = detection frequency

Tap Water
Two tap water samples were obtained at each residence: a first flush and post flush sample. A "first flush" sample measures the lead levels in water that has remained in the pipes for a while. A "post flush" sample was collected after running the tap for 5 minutes. Members of the field crew collected water samples during their field visit, so "first flush" samples were not always collected before water use in the house began in the morning (as prescribed in the project plan). All water samples were collected into polyethylene bottles already containing the appropriate nitric acid preservative and labeled. Samples were transported under chain-of-custody to a commercial laboratory for analysis of lead levels. Table 3.2-6 provides the summary statistics for lead in tap water.

Table 3.2-6 Summary Statistics for Lead in Tap Water

	N	Detection Frequency		Min.	Max.
		DF	%		
First Flush	12	5/12	42%	3	11.4
Post Flush	12	3/12	25%	3	6.0

Units in $\mu g/L$
N = number of samples
DF = detection frequency

Lead in Paint

Chipping and flaking of lead paint is sometimes a source of lead exposure in older homes (those built before 1978). To evaluate this exposure pathway, lead levels in interior and exterior paint were measured at each residence using a hand-held XRF. The measured value and the location where measurements were taken were documented in the field notes. The results are reported in Appendices H3, H4 and H5. A total of 130 out of 144 samples had lead values above 1 mg/cm^2, the national default screening level for leaded paint (HUD 1995). Summary statistics are presented below:

Location	Number of Samples	Mean (mg/cm^2)	Range (mg/cm^2)
Interior	89	4.2	0.3 - 19
Exterior	55	4.8	0.4 - 14

Garden Vegetables

Samples of garden vegetables were obtained at only a single residence. Two varieties were obtained: a leafy herb (mint), and a root vegetable (potato.) A co-located garden soil sample was also collected. These samples were containerized, labeled and transported under chain-of custody to a commercial laboratory for analysis of arsenic, lead, cadmium and zinc. The results are reported in Appendix H6. Arsenic, lead and cadmium were not detected in vegetable samples. These chemicals were detected at low levels in the garden soil. Low levels of zinc were observed in both vegetables and soil.

3.2.2.2 Biomonitoring Program

The biomonitoring program was designed to determine whether residents of properties containing high levels of arsenic and/or lead have increased exposures to these chemicals. Biomarkers of exposure that were measured included blood lead, urine arsenic, and hair arsenic.

The biomonitoring program consisted of two phases: 1) administration of a questionnaire; and 2) biological sample collection and analysis. The 21 residences identified in the Phase II investigation for soil removal were offered the opportunity to participate in the biomonitoring program. An attempt was made to obtain participation from at least one resident per property. However, all participation was strictly on a volunteer basis. A USEPA representative contacted residents to inform them about the study, to determine their level of interest in participating and to administer the questionnaire. Responses from willing participants were recorded and vouchers to visit a clinic in Globeville for sample collection were distributed. All blood, hair and urine samples were collected, containerized and labeled at Concentra Medical Center in Globeville in accordance with the standard operating procedures in the project plan. Following collection, all samples were transferred under chain-of-custody to an approved commercial laboratory for analysis. A discussion of these results is provided below.

Biomonitoring Results

Demographic information was obtained at 17 of the 21 homes scheduled for soil removal. Based upon the information provided on the questionnaire, 69 people reside at these 17 properties. Of these, a total of 15 people from six separate residences volunteered to participate in the biomonitoring program. All biomonitoring results for these individuals have been reported to the participants by letter.

Biomonitoring results are presented in Appendix H8 and are summarized in Table 3.2-7. Key findings are noted below:

- All blood lead results were below the benchmark value of 10 μg/dL. The maximum value was 4 μg/dL, and the geometric mean was 2.2 μg/dL. These values are within the normal range observed in national surveys.

- Arsenic was not detected in any sample of urine. In five cases, the urine appeared to be fairly dilute (based on low creatinine levels), so the detection limits (expressed as micrograms arsenic per gram creatinine) were above the benchmark value of 50 μg/g. In order to confirm that urinary levels were not above normal levels, each of these individuals was offered the opportunity for retesting. However, none chose to accept the offer.

- Arsenic was below the level of detection in 14 of 15 hair samples. In the one sample which was detected, the concentration (0.41 μg/g) was within the normal range. For 2 of the 14 nondetects, because of limited sample mass the detection limit was slightly above the benchmark value of 1 μg/g. In order to confirm that hair arsenic levels were not above normal levels, each of these individuals was offered the opportunity for retesting. However, none chose to accept the offer.

Because of the small number of participants, these biomonitoring data must be interpreted with caution. However, the data suggest that exposure levels to lead and arsenic in these individuals were not significantly greater than normal.

Table 3.2-7 Summary Statistics for the Biomonitoring Program

Lead	
	Lead in Blood
N Total	15
Benchmark	10
N Detection Limits > Benchmark	0
Min	1
Max	4
Geomean	2.2
N > Benchmark	0
Lead in blood units: μg/dL blood	

Arsenic						
Medium	**Units**	**N Total**	**Benchmark**	**Maximum Detection**	**Range of Non-detects**	**Non-detects > Benchmark**
Hair	μg/g hair	15	1	0.41	0.26-1.32	2
Urine	μg/L	15	--	--	10-20	--
Urine	μg/g creatinine	15	50	--	5.8-135	5

-- Not Applicable

N = no. of samples

3.2.3 Quality Assurance/Quality Control

In order to test the accuracy of blood lead analysis at the commercial laboratory, blind Quality Control (QC) standards were inserted into the sample stream at a frequency of 10% of total samples. As seen in Table 3.2-8 results from these samples were within acceptable limits. Blind QC standards for the remaining matrices (urine and hair) could not be acquired in time to meet the expedited sampling program; therefore QC results are unavailable.

Table 3.2-8 Blind QC Standards for Blood Lead Analysis

Control Name	Control Number	Certified Lead Concentration (μg /dL)	Measured Lead Concentration (μg/dL)	% Recovery	Acceptance Limits (%)
Blood 3658	1307	**15.3**	**13**	**85**	**85-115**
Blood 3658	1312	**15.3**	**13**	**85**	**85-115**

In order to determine the accuracy of metals analysis for dust samples, blind QC standards were inserted into the sample stream. Appendix A1 contains a figure which compares the nominal values with the analytical results obtained by XRF and ICP. As seen, ICP results appear more accurate for arsenic, lead and zinc. Inconsistent recoveries for metals measured via XRF suggest that chemical data obtained from ICP analysis of arsenic, lead and zinc for dust samples may be more reliable than XRF.

3.3 <u>Phase III Investigation</u>

Results from the Phase I and Phase II sampling programs, supplemented with the data and findings from the Risk-Based Sampling Program and the Physico-Chemical Characterization Program, indicated that there are properties present in the VB/I-70 site where arsenic and/or lead could be in a range of health concern to people who come into contact with the soils, particularly over many years. The existing data did not indicate a clear spatial pattern of soil contamination that would enable the USEPA to predict where the highest locations are located. For this reason, USEPA tasked Washington Group International, Inc. to undertake a large-scale sampling program designed to support reliable risk assessment and remedial risk management decisions. This program is referred to as the Phase III Investigation. The investigation consisted of two separate stages (Phase IIIA and Phase IIIB), and five primary activities:

- Sampling surface soils (0"-2") in residential yards throughout the study area
- Sampling surface soils in a subset of residential yards using individual grab samples
- Sampling indoor dust in homes
- Sampling vegetables and surface soils (0"-6") from residential vegetable gardens
- Sampling school and park surface soils (0"-2")

As part of the Phase III Investigation, the USEPA expanded the study area south to Martin Luther King Boulevard to include all of the Clayton and Cole neighborhoods. The data quality objectives, study design, and procedures for the field, laboratory and data management activities were detailed in the Phase III Field Investigation Project Plan dated August 4, 1999 (USEPA 1999a), as supplemented by revised SOPs and the Residential Garden Vegetable Sampling and Analysis Plan (USEPA 1999b).

Phase IIIA focused on obtaining access to and sampling properties (including residences, schools, and parks) that had not been investigated in Phases I or II. Garden vegetables, garden soils, indoor residential dust, and schools, parks, and alley soils also were identified for sampling during Phase IIIA.

Phase IIIB consisted of resampling all properties that had previously been sampled in Phase I or II and for which access was granted. The USEPA determined that the resampling was needed because the existing data were judged to be too limited to support clear risk-management decision making. Additionally, residential, school and park properties that had not yet been sampled were targeted for sampling during Phase IIIB. A residential grab sampling program also was completed during Phase IIIB at properties where the composite samples indicated the potential for isolated "hot spot" concentrations.

3.3.1 Property Access

Written consent for property access was gained through a combination of mailings, door-to-door canvassing, phone contacts, and public meetings. Flyers announcing the public meetings are included in Appendix K. A summary of the public meetings is shown below:

Public Meetings

Date	Type
March 10, 1999	Information Session
June 22, 1999	Public Meeting
September 22, 1999	Open House
September 28, 1999	Open House
February 22, 2000	Public Meeting
February 23, 2000	Public Meeting
September 26, 2000	Public Meeting
September 27, 2000	Public Meeting

Generally, written consent for access is required prior to the USEPA collecting any samples from a property. Several properties were inadvertently sampled without access or sampled at the USEPA's direction based on verbal consent from the owner. The summary of access by neighborhood is provided in Table 3.3-1. The Phase III Sampling Program succeeded in obtaining access to 3,026 out of a total 3,931 target residential properties, or 77% of the target properties.

Table 3.3-1 Summary of Phase III Sampling by Neighborhood

	CLAYTON	COLE	ELYRIA	GLOBE-VILLE	SWANSEA	TOTAL
TARGET PROPERTIES	1251	1121	86	92	1381	**3931**
Access Granted	917	801	57	65	1186	3026
Access Granted, Not Sampled[1]	(17)	(6)		(2)	(25)	(50)
Access Granted, Sampled	**900**	**795**	**57**	**63**	**1161**	**2976**
Sampled Without Access Granted	7	9	3	0	12	31
Total Sampled	**907**	**804**	**60**	**63**	**1173**	**3007**
Access Declined	49	19	5	2	41	116
PROPERTY TYPE						
Residential=RES	879	795	58	63	1127	2922
Residential=VAC-RES	0	0	0	0	1	1
Residential=DHA (GOV-RES)	23	1	0	0	41	65
Residential=MBL	0	0	0	0	1	1
Total Residential	**902**	**796**	**58**	**63**	**1170**	**2989**
Schools	2	7	0	0	1	10
Parks	3	1	1	0	2	7
Government Property	0	0	1	0	0	1
Total Sampled	**907**	**804**	**60**	**63**	**1173**	**3007**
OTHER MEDIA SAMPLING						
Gardens	7	9	1	0	2	19
Indoor Dust	21	24	5	11	14	75
PROPERTY ACTIONS						
Phase IIIA Actions						1545
No Action	219	114	5	6	85	428
No Immediate Action	417	470	40	30	136	1091
Immediate Removal Action	8	14	1	0	0	23
Phase IIIB Actions						1444
No Action	103	29	2	2	268	404
No Immediate Action	151	167	10	25	677	1028
Immediate Removal Action	4	2	0	0	4	10

[1] Not sampled due to subsequent access restrictions (43 properties) or lack of area for sampling (7 properties)

On June 11, 1999, the initial letter requesting property access was sent to all home owners, as recorded in the 1998 city tax assessor records, of approximately 2600 properties that had not been sampled during the 1998 Phase I or Phase II sampling programs. Access agreements were sent for the owner to sign and return in the self-addressed postage-paid envelope provided. In the initial response, access agreements were received for 1362 properties, allowing sampling to proceed during the summer and early fall months. Throughout the sampling effort, field personnel spoke with residents and requested and obtained written consent for property access.

On September 30, 1999, a second letter requesting access was mailed to owners of properties that had not provided access and had not been sampled. Access was received at an additional 257 properties through response to the mailing and door-to-door canvassing.

Separate agreements were obtained from residents of 75 homes for access to the home interior and collection of indoor dust during October and November 1999.

The USEPA determined in December 1999 that the data from Phase I and Phase II sampling programs were too limited to support clear risk management decisions. On this basis, USEPA decided to resample those properties previously sampled in 1998, while continuing to gain access to unsampled properties through door-to-door efforts and at public meetings. This second Phase III sampling effort became known as the Phase IIIB Sampling Program. Owners were notified of the planned resampling by letter on March 14, 2000. Signed access agreements were in place from 1998, and field personnel obtained new access agreements where property ownership had changed.

The Denver Housing Authority (DHA) properties are tracked as government, rather than residential, properties in the city tax assessor records. These properties were therefore not initially identified as target Phase III properties. DHA provided a complete list of their properties and written consent for access on July 19, 2000. These properties were sampled as part of Phase IIIB.

Throughout the Phase III program, each home that had not provided access for sampling in response to USEPA's written requests was visited by field crews a minimum of two times, including weekend and/or evening hours in an attempt to gain access to every property. Homes in the southern portions of Cole and Clayton neighborhoods were visited additional times because those areas were not included in the Phase I and Phase II study area and residents were thought to be less familiar with the USEPA sampling effort.

In addition to the residential property access, written permission to sample also was requested and received from the City and County of Denver Parks and Recreation Department, Denver Public Schools, and all private schools included in the sampling program.

3.3.2 Residential Soil Sampling

The residential soil sampling was the largest component of the Phase III Investigation (Figure 3.3-1). The soil sampling was performed to identify properties with elevated levels of arsenic and lead in surface soils and to support reliable exposure and risk assessment calculations, which will be used for risk management decisions regarding the need to remediate residential soil. Composite surface soil samples were collected from all residential properties. Individual grab samples also were collected from selected properties.

3.3.2.1 Phase III Residential Soil Sampling Study Design

USEPA has established the following recommended performance measures for baseline risk assessments in the Superfund program (USEPA 1992b):

- There should be no greater than a 20% probability of requiring remedial action when no action is required; and
- There should be no greater than a 10% probability of not requiring remedial action when action is required.

At the VB/I-70 site, EPA designed the Phase III residential soil sampling program to meet or exceed these performance measures. At this site, a residential property is assumed to require remedial action unless there is at least 95% confidence that no action is required.

For arsenic, this performance measure is met by using the 95% Upper Confidence Limit of the arithmetic mean concentration of arsenic in soil at the property as the exposure point concentration in the baseline risk assessment and as the basis for remedial decision making. That is, if the health risks associated with exposure to the 95% UCL are acceptable, there is at least 95% confidence that the true arithmetic mean of arsenic for the property is below the 95% UCL and that risks are within acceptable limits. However, the use of 95% UCL for arsenic means that some properties where true risks are actually acceptable may be identified as requiring action. The recommended performance measure is to limit the frequency of this type of error to no more than 20%. For the VB/I-70 project, EPA's goal was to ensure that the frequency of this type of this type of decision error was as low as could be achieved with the available sampling and analysis budget. EPA may decide to collect additional soil samples to further reduce this type of error as part of remedial design.

For lead, the established performance measure is met by using the EPA Integrated Exposure Uptake Biokinetic (IEUBK) model or other appropriate mathematical model that describes the probability that an individual exposed to a specified set of environmental lead levels will have a blood lead value that is above a level of health concern. An acceptable level of lead in soil is defined as the arithmetic mean soil concentration within a yard such that a typical child or group of similarly exposed children would have a predicted risk of no more than 5% of exceeding a blood lead level of 10 micrograms per deciliter (μg/dL).

The key design elements of the soil sampling component of the Phase III project are as summarized below.

<u>Sampling Depth</u>
Available data on lead and arsenic levels in residential soils were sufficient to establish that when contamination is present in a yard, it is mainly surficial (0-2 inches), and that concentrations of contaminants in subsurface soil tend to be lower than in the surface soil (USEPA 1999a, Appx C). Thus, Phase III was designed to characterize only surficial soil in residential yards. Once properties that are potentially unacceptable are identified, USEPA may choose to collect subsurface soil samples to help determine the appropriate depth of remediation, as appropriate during remedial design.

Calculation of the 95% UCL

Currently, USEPA has established default methods for calculating the 95% UCL for distributions that are either normal or lognormal (USEPA 1992a):

Normal:

$$UCL = m + t_{1-\alpha,n-1} * \frac{s}{\sqrt{n}} \qquad (1)$$

where:

m	=	arithmetic mean of the data
s	=	standard deviation of the data
n	=	number of samples
$t_{1-\alpha,n-1}$	=	t-statistic for the (1-α) percentile of the t distribution with n-1 degrees of freedom

Lognormal:

$$UCL = \exp\left(m_t + 0.5s_t^{\,2} + \frac{s_t H}{\sqrt{n-1}}\right) \qquad (2)$$

where:

m_t = mean of the log-transformed data
s_t = standard deviation of the log-transformed data
n = number of samples
H = H-statistic from table in USEPA, 1992a

Equations for calculating the 95% UCL of the mean for distributions other than the normal and the lognormal are not readily available.

At this site, data from eight residential properties that were intensively sampled suggest the distribution of arsenic values within a residential property tends to be right-skewed, at least for properties where concentration values are substantially higher than average (see Figure 3.3-1a). This indicates that a log-normal distribution might be appropriate for characterizing the distributions at such locations. However, tests of the distribution at these impacted properties reveal that the data are not well characterized by a lognormal (or a normal) distribution (Figure 3.3-1b). The distribution of values at properties that are not impacted or minimally impacted (mean concentration = 40-70 mg/kg) appears to be more nearly normal (Figure 3.3-1c), but are still skewed at the low end by the presence of multiple values below the detection limit. Because the distributions are not well characterized as either normal or lognormal, use of either equation 1 or equation 2 as the basis for calculating the 95% UCL based on a series of grab samples might yield results that are not accurate.

One way to minimize problems associated with calculating the 95% UCL of the mean for nonstandard distributions is by compositing. This is because, regardless of the shape of the parent distribution, the distribution of the values of composite samples will approach a normal distribution if the number of sub-samples is sufficiently large and the sub-samples are thoroughly mixed, allowing use of equation 1 for calculation of the UCL of the mean at a property. In addition, the variability between composite samples is less than between grab samples, so uncertainty in the mean of composite samples is usually less than for an equal number of grab samples. For these reasons, the Phase III soil sampling study utilized compositing of grab samples collected within a property.

Number of Grab Samples per Composite

In order to estimate the number of grab samples per composite needed to reduce intra-composite variability and to ensure that distribution of composites is approximately normal, Monte Carlo simulations were performed using site-specific data from properties that had been intensively sampled (140-160 data points per property). In these simulations, grab samples of size j (j = 5, 10, 15, 25, 30, 50 grabs per composite) were repeatedly drawn, and the composite mean was calculated as the mean of the grab samples. Then the distribution of the composite values was tested for normality. The results are presented in Appendix E of the Final Phase III Field Investigation Plan (USEPA 1999a). Based on these tests, a set of 10 sub-samples was found to be adequate to ensure that the distribution of the composites drawn from minimally impacted properties (sample mean = 40-70 mg/kg) will be approximately normal.

At the intensively sampled properties that were clearly impacted (sample mean = 390-2370 mg/kg), the number of grab samples per composite needed to ensure that the distribution of composites is approximately normal is about 15-25. Thus, the distribution of the 10-point composite samples from such a property is likely to be somewhat right-skewed. For right skewed distributions, the median is less than the mean and therefore a single 10-point composite sample is more likely to be below the true mean than above the true mean. However, some 10-point composite sample values may be raised by very high although infrequent values and the mean of the three 10-point composite samples should, therefore, approach the true mean and use of equation 1 to calculate the 95% UCL could underestimate the true UCL. At such a location, it is expected that the identification of the property as potentially unacceptable can readily be made based on the sample mean. That is, if the sample mean indicates unacceptable risks, the property may be classified as potentially unacceptable without regard to the value of the UCL. Therefore, the possibility of incorrectly identifying the property as acceptable when it is really not acceptable is very small.

Number of Composites per Property

The number of composites per yard depends on the acceptable probability of requiring remedial action when no action is required (false positive). This is the case when a property is incorrectly identified as being above a level of concern when it is actually below a level of concern. In general, as the number of composites increases, the chances of making this type of error decreases. However, the exact number depends on the expected difference between the level associated with unacceptable risk and the typical level in unimpacted properties. That is, the wider the difference between the mean value at unimpacted properties and the level associated with unacceptable risks, the fewer samples that are needed. As noted above, EPA guidance (USEPA 1992b) recommends that the value be no more than 20%, and the goal of the study is to reduce the false positive error rate to the maximum extent that available resources will permit.

In order to investigate the relationship between the false positive error rate and the number of composites at this site, a Monte Carlo simulation was performed based on an assumed distribution of arsenic levels in unimpacted properties. This distribution was based on available data on arsenic levels in residential surface soil samples collected in the vicinity of the Globe plant (see Figure 3.3-1d). Each data point represents the measured arsenic value in a four-point composite from a residential property. Values higher than 70 mg/kg were assumed to represent potentially impacted properties, and were not considered in the approximation of the background distribution. Even though these data are from outside the VB/I-70 study area, the distribution of values is judged to be reasonably predictive for those that are expected to occur within the study area. Based on these data, the distribution of true property means at an unimpacted property was modeled as:

$$\text{Background} = \text{LN}(21,13)$$

where:

LN(21, 13) = lognormal distribution with parameters 21 and 13
21 = mean of the (untransformed) data
13 = standard deviation of the (untransformed) data

From this distribution, a series of random "true means" were selected, each representing a randomly selected background property. The inter-grab sample variability at each property with "true mean" m was simulated based on the observed range of inter-grab-sample variability at the eight properties that had been intensively sampled. At these properties, the coefficient of variation (CV = standard deviation/mean) ranged from about 0.8 to 1.2. Because this range was based on only 8 properties, a slightly wider range of variability (CV = 0.7 to 1.3) was assumed. Based on this, the standard deviation at a simulated property was simulated as:

$$s = m^*CV$$
$$CV = \text{TRI}(0.7,1.0,1.3)$$

where:

TRI(0.7,1.0,1.3) = triangular distribution with parameters 0.7, 1.0, 1.3
0.7 = minimum value
1.0 = mode (most likely value)
1.3 = maximum value

For each simulated "true mean" and "true standard deviation," a series of grab samples was selected at random, and combined into n composites of j grab samples per composite. From these, the inter-composite means and standard deviation were calculated and used to calculate the 95% UCL using equation 1 (above). The false positive error rate was assessed by counting the number of properties where the "true mean" indicated risks were acceptable but the 95% UCL indicated risks were unacceptable.

Because a site-specific acceptable level of arsenic in soil had not been derived, it was necessary to assume a value for the purposes of planning the design of Phase III. For arsenic, a value of 70 mg/kg was adopted. Employing an assumed acceptable level of 70 mg/kg and the estimated background distribution described above, and employing a grab sample size of 10, the simulated false positive error rates are as shown below:

Number of Composites	Estimated False Positive Error Rate
2	15%
3	4.1%
4	2.6%
6	1.5%

As seen, if only 2 composites were used, there would be a relatively high probability (about 15%) of declaring a property to be potentially unacceptable when it was actually acceptable. Use of three composites reduces the rate to about 4%, and this error rate can be reduced further by going to 4 or 6 composites. Although an error rate of 4% is very good by most standards, because of the large number of properties which must be evaluated at this site, even a rate this low results in a large number of errors (up to 120 residences).

Based on these findings, a phased approach to sampling and reducing false positive errors was developed. That is, samples collected at each property tested in Phase III included three composites of 10 grab samples each. All properties whose 95% UCL indicates unacceptable risks will be considered potentially unacceptable. However, because of the possibility of a false positive error, EPA may consider performing further sampling activities at such locations (especially those where the sample mean is close to or below the risk-based concentration) in order to determine whether the property actually does exceed an acceptable level. Further sampling may be done as part of remedial design.

Sampling Procedures
The Project Plan specified that thirty subsamples be located approximately equidistant throughout each property. Several properties had limited yard areas that could not accommodate thirty samples without potentially damaging the sod. For these cases, USEPA developed a guideline which required a reduction in the number of subsamples from thirty to fifteen if placing thirty subsamples would result in the locations being less than five feet apart (which equates to a total area of exposed soils less than 750 square feet).

The locations were flagged following measurements of all yard soil areas, which excluded paved sidewalks, driveways, large trees and bushes, and garden areas. The number of subsamples to be equally spaced within each area of the yard was then calculated to be proportional to the percent of the total yard represented by that area. Locations were flagged sequentially using three colors of flags representing each of the three composite samples. In this manner, each composite contained ten (or five in small yards) subsamples from locations throughout the yard.

All surface soil locations were collected from the top 0-2" interval using a 2"-diameter hand corer. In areas of dense sod, the sod layer was carefully lifted and the soil immediately beneath the sod was sampled. Areas covered with less than two inches of gravel were sampled immediately beneath the gravel. All sample holes were filled with top soil and any sod removed was replaced.

Each composite sample was homogenized following collection, and rocks, vegetation and other non-soil matter were removed prior to containing the sample in a labeled sample bag. Residents who requested a split sample were provided a portion of each homogenized composite sample, identified with the USEPA sample number and sample date/time.

<u>*Sampling Results*</u>
The composite soil sampling results from analysis using energy dispersive x-ray fluorescence (EDXRF) are summarized in Figures 3.3-2a, 3.3-2b and 3.3-2c. The number of properties by concentration range is presented, with ranges of mean arsenic concentrations, 95% UCL of the mean of arsenic concentrations, and the mean lead concentrations within individual properties presented in separate figures.

A total of 935 properties did not contain levels of arsenic in any of the composite samples above the method detection limit (MDL) of 11 mg/kg. Appendices A4, A5 and A6 present the basis for the project MDLs. Nondetect results were assigned a value of one-half the MDL, or 5.5, for the purposes of calculating a conservative mean and 95% UCL. Therefore, properties where one or two samples were nondetect and the other(s) just above the MDL have a calculated mean (602 properties) or 95% UCL (four properties) below the MDL of 11 mg/kg. The majority of residential properties sampled have low levels of arsenic. Thirty-one percent of properties sampled have 95% UCL concentrations either below or near the MDL.

The distribution of mean lead concentrations presented in Figure 3.3-2c shows that only eighteen sampled properties had one or more results below the MDL of 52 mg/kg, and the most frequently observed mean values were between 100 and 150 mg/kg. These data indicate that there is a detectable background lead level at the site associated with naturally occurring and also likely widespread urban sources. As with arsenic, most residential properties at this site contain relatively low levels of lead and 91% are below the USEPA default lead soil screening level of 400 mg/kg.

3.3.2.2 Grab Sampling

Grab samples were collected at selected properties where the Draft Baseline Human Health Risk Assessment indicated the potential for unacceptable risks from a short-term exposure to arsenic in an isolated area smaller than the entire yard, but for which the data did not indicate an unacceptable chronic risk. Analysis of all Phase III composite sample results indicated that 119 properties theoretically could contain this type of "hot spot" concentration. These properties were identified by assuming the maximum arsenic concentration measured in a composite sample from the yard contains nine subsamples collected from locations at background concentrations and the tenth subsample from a hot spot. This maximum theoretical hot spot concentration (MTHC) was used as the concentration term in a screening level assessment of short term risk. At yards where short term risk was indicated, additional grab samples were collected.

In order to investigate whether the predicted "hot spots" actually occur within the selected yards, individual grab samples were collected from the 119 properties, in similar locations as those previously subsampled for compositing. Sample collection procedures were identical to those used to collect composite samples, except that the 30 individual samples were placed into separate sample containers and numbered for individual analysis.

The arsenic results derived from the composite sample data, theoretical hot spot concentration predicted from the highest composite value measured in the yard, and grab sample data are presented in Appendix I and are summarized Table 3.3-2.

Table 3.3-2 Theoretical Arsenic Hot Spot Analysis

Result	Arsenic MTHC	Composite Samples		Grab Samples	
		Max Conc.	95% UCL	Max Conc.	Mean
Average Value	1271	142	164	363	118
Range of Values	1010 - 1570	116 - 172	127 - 218	24 - 1492	14-367

Results in mg/kg

3.3.2.3 Comparison of Composite and Grab Sampling Results

A comparison of the available residential composite and grab sample data was performed to supplement other data quality indicators to be considered in the final risk management decisions.

As discussed in Section 3.3.8 and Appendix A6, the data from the composite samples were determined to be normally distributed. Thus, the use of the *t*-equation to calculate a 95% UCL for arsenic was considered valid. The use of the *t*-equation was the intended data quality assessment approach, as set forth in the Project Plan.

For the 119 properties that were resampled, the UCLs of the composite data are compared to the means of the grab sample data in Figure 3.3-3.

If both composite and grab sample data are normally distributed at each property, approximately 95% of the composite UCLs should exceed the mean concentration of the grab samples, with 5% failing to exceed the grab mean. Comparison of grab mean vs. composite UCLs presented in Table 3.3-2 and Figure 3.3-3, indicates that approximately 83% of the UCLs for the composite samples exceeded the mean for the grab samples, instead of the 95% anticipated exceedence rate. This leaves a discrepancy of about 12% between the actual and expected number of composite UCL exceedences.

Analysis of this discrepancy indicates that the vast majority (85%) of the cases where the grab mean exceeds the composite UCL, the grab samples at the property have relatively high-valued or outlier data. Data are considered to be high-valued or outlier if they exhibit concentrations more than four times the composite average. When high-valued grab samples are not present, only three composites UCLs fail to exceed the means of the grab samples. This equates to a rate of approximately 3%, or less than the 5% expected failure-to-exceed rate. Therefore, composite UCLs exceed grab means at a rate greater than 95% when the high-valued grab samples are accounted for.

3.3.2.4 Comparison of Intensive Risk-Based Sampling to Other Sampling Programs

The eight intensely sampled properties described in Section 3.2 have been subject to sampling under several different programs, including Phase I, Phase II and Phase III investigations. The Phase III investigation collected three ten-point composites from each property. Table 3.3-3 compares the results of the Intensive Risk-Based Sampling to the 1998 and Phase III Sampling at each location.

Only three of the eight properties were sampled during Phase III, one of which was sampled following removal of contaminated soil. Therefore, overall program comparisons cannot be made. The limited data do exhibit the higher variability expected in the Risk-Based and Phase I grab samples relative to the Phase III composite samples.

Table 3.3-3 Comparison of Intensive Risk-Based Sampling Results to 1998 and Phase III Sampling Results

Property ID	ARSENIC MEAN				ARSENIC 95% UCL			ARSENIC MAX				LEAD MEAN				LEAD MAX			
	Intensive RBS	1998		Phase III	1998		Phase III	Intensive RBS	1998		Phase III	Intensive RBS	1998		Phase III	Intensive RBS	1998		Phase III
		Phase I	Phase II		Phase I	Phase II			Phase I	Phase II			Phase I	Phase II			Phase I	Phase II	
$1_{(a)}$	970	900	450	<11	2160	772	<11	4514	1700	1600	<11	1602	470	684	<52	4829	790	1900	<52
2	1889	2177	743	NA	7176	1484	NA	11785	5600	3300	NA	1258	1133	628	NA	4889	2100	1800	NA
3	386	1006	303	NA	3338	459	NA	2729	2600	550	NA	297	301	265	NA	1542	530	640	NA
4	511	289	491	NA	1007	798	NA	2536	780	1500	NA	1051	797	806	NA	3127	1900	1600	NA
5	2365	986	1331	NA	3093	1508	NA	16176	2400	3200	NA	1671	743	987	NA	5072	1500	2300	NA
6	74	90	NA	42	166	NA	54	231	140	NA	49	134	104	NA	154	469	140	NA	191
7	48	64	NA	26	122	NA	34	164	98	NA	31	288	160	NA	188	498	200	NA	193
$8_{(b)}$	232	240	NA	NA	403	NA	NA	1716	350	NA	NA	220	133	NA	NA	635	150	NA	NA

All results reported in mg/kg
(a) Property 1 sampled during Phase III subsequent to removal action

(b) Access declined for Phase III sampling
NA: Not analyzed

3.3.3 Residential Dust Sampling

One pathway by which residents may be exposed to contaminants in soil is by transport of outdoor soil into the house where it combines with other sources to form house dust. In the absence of site-specific data, assumptions must be made regarding contaminant concentrations and exposures associated with indoor dust relative to outdoor soils. Therefore, the USEPA undertook a study to define the relationship between arsenic and lead levels in soil and dust at this site. As shown in Figure 3.3-4, a total of 75 properties was selected for this study. These properties were chosen based on a stratified random analysis, providing for a range of arsenic and lead levels in yard soil and spatial representativeness across the site, as well as resident consent for access within the home. Samples were collected in October and November 1999. Two samples were collected from separate duplex units at one property, for a total of 76 samples.

Dust samples were collected from the interior of residential homes using a high volume vacuum sampler (HVS3 model) in accordance with the EPA approved SOP No. ISSI-VBI70-04. Measured template areas of carpet and other flooring within living areas, including kitchens, family rooms, bedrooms, hallways and entryways, were sampled. In most cases, two template areas were collected per living space. Thus, the total number of sub-samples collected within a residence was dependent upon the number of living spaces. In the case where a resident had more than ten living spaces, only one template per living space was collected. Sub-sample locations within a living space (living space sample points) were focused on areas with the greatest potential for exposure. This was typically along the center axis of the living space. Corners of rooms, areas beneath furniture, etc., were not likely high exposure areas (even if especially dusty) and were not sampled.

At each sub-sample location within the house to be sampled, the template was placed on the sampling surface. The vacuum was turned on and the nozzle was placed in one corner of the sampling area, then the flow rate and pressure drop was adjusted. The two factors that affect the efficiency of the sampling system are the flow rate and pressure drop at the nozzle. The pressure drop at the nozzle is a function of the flow rate and distance between the surface and the nozzle flange. The flow rate over level loop carpet or hard surfaces was initially (October 20, 1999 - November 17, 1999 at 1415) set at 5 inches of water, in accordance with the instrument operation manual. The flow rate over level loop carpet or hard surfaces was subsequently (November 17, 1999 at 1415 - November 23, 1999) set at 6.5 inches of water based on a recommendation from the Field Quality Assurance Coordinator during an audit. Sample collection proceeded by passing the nozzle over each area of the template four times.

As presented in Figure 3.3-5a and 3.3-5b, concentrations of arsenic and lead in indoor dust remained relatively consistent over a wide range of yard soil concentrations, and are poorly correlated to yard soil concentrations. These data indicate that the levels of arsenic and lead that residents are exposed to from indoor dust do not increase as potential exposure levels from the yards increase.

3.3.4 Residential Garden Sampling

Another pathway by which residents might be exposed to soil-related contaminants is ingestion of vegetables grown in home gardens that contain contaminated soil. In order to obtain site-specific data on this potential exposure route, garden vegetable and garden soil samples were collected from residential gardens. At each location where a vegetable sample was collected, a co-located sample of garden soil also was collected.

Candidate gardens were identified from property sketches generated during soil sampling, and residents were contacted by phone to determine whether vegetables remained available. Sampling began on October 7, 1999 and was completed in two weeks. A total of 19 residential gardens was sampled and 72 vegetable samples were collected, as located in Figure 3.3-4.

The dimensions of the garden were measured and a diagram was prepared identifying crop types and locations. The locations of vegetable and soil samples collected from the garden were recorded. Samples were prepared for each type of vegetable still growing in the garden by harvesting a sufficient number to produce the required sample mass of 200 grams. The vegetables were washed with potable quality water and a vegetable brush, then rinsed with deionized water, in accordance with Standard Operating Procedures (SOP No. ISSI-VBI70-06). All vegetable samples were stored in a freezer following sample collection and prior to shipment to the laboratory.

At each vegetable sample location, a corresponding 0-6" grab soil sample was collected using a hand corer. Soil samples were collected next to the plant being sampled, at a maximum of 6 inches from the plant.

The results for garden vegetables, garden soils and corresponding yard soils are provided in Appendix J. Arsenic and lead in garden soils were generally lower than levels found in the yard soils at each property, which may be related to soil, peat and fertilizer amendments that typically are added to gardens. The wet weight mean concentration of arsenic in garden vegetables was 0.044 mg/kg, with individual property means ranging from 0.00289 to 0.171 mg/kg. The wet weight mean concentration of lead in garden vegetables was 0.15 mg/kg, with individual property means ranging from 0.0034 to 1.21 mg/kg. Garden vegetable concentrations are compared to the co-located garden soils in Figures 3.3-6a and 3.3-6b. In general, arsenic and lead concentrations in vegetables remained consistently low throughout the range of garden soil concentrations.

3.3.5 School and Park Sampling

The Phase III Sampling Program included collecting surface soil grab samples from all schools and parks within the study area as shown in Figure 3.3-7. Although several schools and parks had been sampled during Phase I, a limited number of samples had been collected at each property. During Phase III, 30 surface soil grab samples were collected from play areas and grassy areas at each school and park within the site. The ten schools and seven parks sampled are listed in Table 3.3-4.

Table 3.3-4 School and Park Sampling

School/Park Name	Address	Neighborhood	Sample Locations
Family Star Montessori*	1331 E. 33rd Ave.	Cole	94*
Mitchell Elementary	1350 E. 33rd Ave.	Cole	30
Harrington Elementary	2401 E.37th Ave.	Cole	30
Swansea Elementary	4650 Columbine St.	Swansea	30
Cole Middle School	3240 Humboldt St.	Cole	30
Northeast Montessori	3503 Marion St.	Cole	30
Annunciation School	3536 Lafayette St.	Cole	30
Wyatt-Edison School	3620 Franklin St.	Cole	30
Clayton Foundation*	3605 Martin Luther King Blvd.	Clayton	90*
Proposed New School	3100 E. 40th Ave.	Clayton	30
Swansea Park	2650 E. 49th Ave.	Swansea	30
Shafer Park	2700 E. 37th Ave.	Clayton	30
Dunham Park	2800 E. 44th Ave.	Swansea	30
City of Nairobi Park	3500 Cook St.	Clayton	30
Russel Square Park	3600 Vine St.	Clayton	30
Saint Charles Place Park	3777 Lafayette St.	Cole	30
Elyria Park	4801 Race St.	Elyria	30

* Multiple Areas Sampled:
Family Star Montessori - School Yard, Playground, School expansion lot (33RD & Humboldt St-SW Corner)
Clayton Foundation - Hallet Hall Playground, Barth Hall Playground, Garfield Montessori Playground, Martin Luther King Jr. Playground

The Phase III school and park sampling results are summarized in Table 3.3-5. The results indicate that concentrations of arsenic are low with mean values generally less than the MDL of 11 mg/kg. Anomalous arsenic results were reported at a school (identified as S1) for two samples in close proximity to each other (1517 and 70 mg/kg of arsenic). The area was resampled by collecting four grab samples in the same general area. The resampling occurred during construction and replacement of a sidewalk. The results indicated low arsenic levels consistent with the remainder of the property. The area where the high levels originally were indicated has subsequently been covered by the reconstructed sidewalk. Mean results for lead ranged from 67 to 256 mg/kg. The highest concentrations of lead were detected in several samples at school S1, but the property mean concentration is much lower at 256 mg/kg.

Table 3.3-5 Arsenic and Lead in School and Park Surface Soils

Category	Property Code	Arsenic (mg/kg)			Lead (mg/kg)		
		Mean	Max	Min	Mean	Max	Min
School	S1	26	1517*	<11	256	1811*	61
	S1-Resample*	<11	16	<11	79	111	56
	S2	<11	17	<11	133	901	<52
	S3	<11	13	<11	67	159	<52
	S4	<11	12	<11	94	164	<52
	S5	<11	<11	<11	116	354	<52
	S6	<11	19	<11	200	628	55
	S7	<11	11	<11	172	316	100
	S8	<11	13	<11	70	255	<52
	S9	<11	12	<11	104	245	<52
	S10	<11	17	<11	117	352	<52
Park	P1	<11	18	<11	132	290	<52
	P2	<11	17	<11	131	308	<52
	P3	<11	21	<11	218	294	110
	P4	<11	12	<11	91	153	<52
	P5	<11	15	<11	144	299	67
	P6	<11	21	<11	214	398	<52
	P7	<11	19	<11	239	614	<52

* Resampling: 4 grab samples collected in area where previous samples indicated high conc.

3.3.6 Alley Investigation

The Project Plan for the Phase III investigation included soil sampling in alleyways throughout the study area. Four to six alleys were to be selected based on the residential soil sampling phase of the field investigation, with preference given to alleys adjoined by multiple sampled properties and where at least one property was clearly impacted by arsenic (e.g., mean value is greater than 200 mg/kg). However, visual inspection of all alleyways in the study area revealed that no alleyways were suitable candidates for sampling. All alleyways are concrete or asphalt paved, with areas of accumulated soils on top of pavement and areas of exposed soil where the pavement is cracked or missing. There is limited potential for exposure to soils within the alleyways and therefore the alleyway sampling was eliminated from the program.

3.3.7 Comparison of Bulk and Fine Fraction Soils

The main pathway by which humans are likely to be exposed to contaminants in soil is by ingestion of soil particles adhering to the hand. Although data are limited, it is generally expected that small soil particles are more likely to adhere to the hands than coarse particles. The smaller fraction soils (<250 um) were isolated from the bulk fraction by passing the soil through a #60 sieve. The fine fraction portion of the sample was then compared to the course sieved (to remove particles larger than 10 mm), or bulk fraction of the same sample. All soils collected during Phase III were coarse sieved and the bulk fraction submitted for analysis. Studies at other sites have shown that concentrations of metals in the fine fraction can sometimes be somewhat higher (e.g, 10-30%) than in the bulk sample. Therefore, the relationship between metals in the bulk and fine fraction soils at this site is important to understand for the purposes of the risk assessment.

In Phase III 149 archived soils were dried and sieved into two bulk and fine fractions and analyzed using EDXRF. The soils were chosen based on the arsenic and lead concentrations in the bulk fraction in order to stratify the arsenic and lead concentrations and the geographic area of the site. The results are summarized in Table 3.3-6. The fine fraction concentration exceeded the bulk fraction concentration in 70% of the samples for arsenic and 74% of the samples for lead. The average percent difference for arsenic between the bulk and fine fractions was 34%. The average percent difference for lead between the bulk and fine fractions was 16%. This value could be biased high, due to the fact that a majority of the concentrations for arsenic were below 100 mg/kg. Therefore a slight difference in concentration would produce an even higher percent difference.

Table 3.3-6 Summary of Phase III Bulk and Fine Fraction Soils

Chemical	Total Number of Samples	Fine > Bulk	Bulk > Fine	Both Fractions Equal
Arsenic	149	104	44	1
Lead	149	111	38	0

The concentrations of the metal present in the bulk and fine fractions were compared using linear regression analysis and the resulting graphs are presented in Figures 3.3-9a and 3.3-9b. The slope, intercept values, and linear correlation values are presented in the table below.

Table 3.3-7 Linear Regression Values for Phase III Bulk Samples and Fines

Chemical	Slope	Intercept	Linear Correlation (R2)
	Best	Best	Best
Arsenic	1.1981	2.4791	0.939
Lead	1.3309	53.72	0.8275

The linear regression indicates that the arsenic concentration measured in the fine fraction is, on the average, nearly equal to that in the bulk fraction. For lead, there is a tendency for the concentration values in the fine fraction to be somewhat higher than in the bulk fraction. This is relatively consistent with the results from the Physico-Chemical Characterization Study as described in Section 3.1.2. The Physico-Chemical Characterization Study found that there was little difference between the bulk and fines fraction for arsenic and lead, but showed that there was a small negative bias in the estimation of the bulk concentration for lead which would tend to underestimate the concentration in the fines at low concentration values.

3.3.8 Data Quality Assessment

Chemical analysis of the Phase III site characterization samples was conducted under a comprehensive quality assurance program. The program included requirements for the collection, preparation, and analysis of quality control samples, as specified in the Project Plan (USEPA 1999a), Section 4.0 Quality Assurance Project Plan (QAPP), and related Standard Operating Procedures for sample collection, preparation and analysis.

All soil samples were prepared and analyzed at the field laboratory operated by Washington Group International, Inc. Samples were prepared by homogenizing the soil followed by complete drying, bulk sieving, and grinding of a portion of the sample. The remaining raw soil sample was archived. The prepared soil sample was analyzed using a QuanX Energy Dispersive X-Ray Fluorescence Spectrometer (EDXRF). Electronic instrument results were reviewed and loaded into the project database. Confirmation analysis was performed on over10% of the soil samples by submitting a split sample for analysis by the EPA Method 6010B, Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP) at a commercial laboratory.

An assessment of the data quality was performed daily throughout the program to verify compliance with the quality control criteria and to identify necessary corrective actions. An assessment of all Phase IIIA, Phase IIIB, and Phase IIIB Grab sample analytical data, including residential surface soil, garden soil, garden vegetables and indoor dust, has been performed to verify that the data set is consistent with and meets the data quality objectives identified in the QAPP. The data quality assessment involved verification of the precision, accuracy, representativeness, comparability, and completeness of the data. The results for Phase IIIA and IIIB document that the data are usable for their intended purpose of identifying average surface soil concentrations and supporting the Baseline Risk Assessment. The results for Phase IIIB Grab document that the data are useable for their intended purpose of identifying the range of soil concentration at selected properties and supporting the Baseline Human Health Risk Assessment.

In Phase IIIA, 5207 soil samples were collected from residential yards, vegetable gardens, schools, and one park. The quality control sample results are presented in Appendix A4. A statistical soil distributional analysis provides strong evidence that the composite sample data within these properties are normally distributed, with the exception of very low and high concentrations.

In Phase IIIB, 4368 composite soil samples were collected from residential yards. The quality control sample results are presented in Appendix A5. A statistical soil distributional analysis provides strong evidence that the composite soil sample data within these properties are normally distributed, with the exception of very low and high concentrations.

In Phase IIIB Grab, 3585 grab soil samples were collected from 119 residential yards, five schools, and six parks. The quality control sample results are summarized in Appendix A6. The soil distributional analysis showed higher variability within the grab samples as compared to composite samples collected from the same property, as expected. The coefficients of variation for grab samples were below 1.0 approximately 80% of the time as compared to the coefficients of variation for composites collected from the same properties which were below 1.0 98% of the time.

The analysis of soil samples in all the studies conducted at the VB/I70 site was performed using XRF as the primary method, with ICP as the confirmation method. In general, the two methods yield very similar values for arsenic but across the duration of the Phase III program there has been a tendency for XRF arsenic results for site soils to be slightly higher than ICP arsenic results. A similar pattern was observed in the Physico-Chemical Characterization Study and the Risk-Based Sampling Study. This apparent difference is not observed in site specific performance evaluation (PE) samples. The basis for this is not certain but may be because the chemical/physical state of arsenic in spiked PE samples is not identical to that in site soils.

Given the tendency for the XRF method to yield somewhat higher arsenic values than the ICP method at this site, it is important to determine which method should be considered most nearly accurate. To make this determination, USEPA performed a small study in which a set of soil samples that had been analyzed by both XRF and ICP were analyzed by a third method, neutron activation analysis (NAA). It is believed that NAA is likely to be free of the potential limitations that may account for the difference between arsenic results measured by XRF and ICP such as incomplete extraction or interference by lead.

USEPA chose 16 soils for analysis by NAA. The soil samples were chosen to represent the full range of arsenic concentrations detected at the site. The results for XRF, ICP, and NAA for all 16 samples are reported in Appendix A3. The arsenic concentrations in the PE samples measured by NAA were in general, higher than the nominal values. The arsenic concentrations measured by ICP were in general lower than the values measured by NAA. The arsenic concentrations measured by XRF compared well to the NAA results. On the basis of this comparison, shown graphically in Appendix A3, the arsenic concentrations in soil measured by energy dispersive XRF are considered to be the most accurate.

Section Four

4.0 NATURE AND EXTENT OF CONTAMINATION

Washington Group performed geostatistical analyses on the arsenic and lead sample data for surface soils at the VB/I-70 site. Geostatistical analyses, including the techniques of variograms and kriging, are commonly-used approaches when sample data exist in a large spatial area, such as the VB/I-70 study area (Myers 1997; EnviroGroup 1997). Spatial data require special analytical techniques in order to extract the maximum amount of information available from the data and to minimize the uncertainty associated with concentration estimates and contaminant distribution maps. Geostatistical techniques have proven to be especially appropriate in the analysis of spatial data and in the assessment of uncertainty. Details of the geostatistical analyses performed appear in the following sections.

4.1 Data Analysis

A total of 3,293 arsenic and 3,293 lead Phase III surface soil samples was used to evaluate the metals concentrations across the site. The samples are composite samples created in a two-step compositing and analysis approach. Arsenic sample concentrations ranged from nondetect to over 750 mg/kg. Geostatistical analysis indicates that arsenic concentrations are below 36 mg/kg over most of the site, but extreme values, i.e. greater than 300 mg/kg, occur at a few scattered locations across the site. Lead concentrations range from nondetect to over 1,100 mg/kg but tend to follow a different spatial distribution than arsenic.

4.1.1 Types of Sample Data

The Phase III Investigation data were used in the site-wide analysis. Composite sample data were generated using the sampling, subsampling, homogenization, and analytical protocols, as described in Section 3.3. At each residential property meeting a minimum size requirement, 30 equally-sized soil subsamples were collected. These 30 subsamples were combined into three groups of 10 subsamples to produce three composite sample volumes for the property. For those properties that did not meet a specified size, only 15 equally-sized soil subsamples were collected. The 15 increments were combined into three groups of five to create three composite sample volumes for mixing and analysis. These composite sample volumes were then mixed before being subjected to analysis by X-ray fluorescence (XRF) to determine the concentration of the composited material. The three analytical results from the XRF were then averaged to produce a single soils concentration value for each property for both arsenic and lead. Individual soil grab samples were collected and analyzed by XRF from school yards and parks within the study area.

4.1.2 Estimation of Population Distribution Parameters

Washington Group performed standard statistical analyses on the composite arsenic and lead data. This included calculation of the minimum and maximum concentrations, the mean, variance, standard deviation, median, and coefficient of variation. Minimum concentrations reflect nondetect values (ND), which incorporate the method detection and practical quantitation limits. The site-wide data indicated highly-skewed, lognormal-type distributions for both arsenic and lead. This result can be seen in the histogram graphs shown in Figures 3.3-2a and 3.3-2c for arsenic and lead respectively, which categorize the metals data in 50 mg/kg concentration ranges.

The skewed nature of the data is typical of environmental contaminant distributions, with a large number of the data showing lower concentrations and a smaller number showing higher concentrations combined with a few extreme values. Concentration values at the VB/I-70 site span approximately three and four orders of magnitude for arsenic and lead respectively.

Despite the similarity of skewness in each of the histograms, the histograms exhibit some unique characteristics. The arsenic histogram displays the mode, the most frequently occurring value, in the first concentration category (ND-50 mg/kg). Sample data indicate that 34% of the properties are at or below the method detection limit of 11 mg/kg. Almost 80% of the properties are below the practical quantitation limit (PQL) of 36 mg/kg for arsenic. This leaves only 34 properties, approximately 1%, above 300 mg/kg.

In contrast, the lead histogram exhibits the mode in the 100–150 mg/kg category, not the lowest category (ND–50 mg/kg), which contains only about 1% of the properties. The vast majority of the properties (approximately 90%) fall between 50 and 400 mg/kg. Only 8.4% of the properties fall above 400 mg/kg, with 3.4% exceeding 500 mg/kg. Based on the comparison of the individual histograms, the arsenic and lead data sets appear to be quite different in nature. The lead distribution is more centered than the arsenic distribution, but it is not centered sufficiently to qualify as a normal distribution. Summary statistics for the site sample data are shown in Table 4-1.

Table 4-1 Summary Statistics

STATISTIC	CONTAMINANT	
	Arsenic	Lead
Minimum (mg/kg)	<11	<52
Maximum (mg/kg)	759	1,131
Mean (mg/kg)	34	216
Variance $(mg/kg)^2$	3,531	16,577
Standard Deviation (mg/kg)	59	129
Median (mg/kg)	12	181
Number of Samples	3293	3293
Coefficient of Variation	1.7	0.59

4.1.3 Correlation Analysis

Washington Group performed a statistical correlation and linear regression analysis on the arsenic and lead composite data. Results of the analysis appear in Figure 4-1, where arsenic values appear on the x-axis and lead values appear on the y-axis. This scatterplot of data indicates a wide pattern of dispersion between individual As/Pb pairs. To achieve good correlation, a fairly tight linear pattern is required. This graph indicates that knowing the concentration of either arsenic or lead provides very little information regarding the concentration of the other. Thus, the regression results confirm that only a small degree of correlation, 0.296, exists between the variables. This value is far from the required minimum correlation coefficient of 0.90 required for other VB/I-70 analyses. Because large relative differences exist between samples at the same location, it suggests that their spatial distribution may also show significant differences.

4.2 Variogram Analysis

Variogram analysis, or variography, is a fundamental step in a geostatistical analysis to quantify the degree of spatial variability and spatial correlation structure of the contamination. It has been widely documented in the earth and environmental sciences that nearby samples generally have concentrations more similar than samples that are further apart (Matheron 1965; David 1977; Isaaks and Srivastava 1987; Myers 1997). In statistical terms, this means that the samples are correlated. Correlation is useful information that can be captured and used to minimize estimation errors of contaminant concentrations.

Variogram analysis performs the task of capturing correlation information by comparing sample data at different distance intervals. Generally, as the distance between samples increases, the variability also increases, with a corresponding decrease in the correlation. Eventually, at some distance, the variability reaches a maximum (called the sill), indicating that correlation between samples no longer exists and that samples are independent.

4.2.1 Arsenic and Lead Variography

Washington Group performed variographic studies on the arsenic and lead data at the site, analyzing each metal separately. Separate analysis of individual parameters is traditionally performed because parameters may exhibit significantly different spatial distributions (David 1977; Myers 1997). If such differences exist, the individual spatial characteristics of each parameter can be applied to the estimation process (kriging) so that more accurate and reliable spatial distribution models can be developed.

Five different directions were analyzed: north-south, northeast-southwest, east-west, northwest-southeast, and an omni-directional variogram (all directions simultaneously). The spatial variability in these five directions was analyzed for both arsenic and lead.

Experience has shown that the spatial variability can differ dramatically in different directions; thus, it is appropriate to investigate several directions during the variogram analysis. Situations where the variability is equal in all directions produce variograms that are said to be isotropic and the spatial continuity can be visualized as circular. Situations where variability is not equal in all directions produce anisotropic variograms, with a short and long axis of spatial continuity and can be visualized as elliptical in nature. Anisotropic variograms were found for both arsenic and lead data at the VB/I-70 site.

Due to the high variability in the data, several types of variogram analyses were also performed. Different types of variogram analyses can often mitigate the influence of the high variability of the sample data values. These variogram types included untransformed data variograms (absolute), general relative variograms (relative to the mean), local relative variograms, and logarithmic variograms (Ln transform). The variogram graphs indicated that the best results were for the untransformed data.

Variogram graphs for arsenic appear in Figures 4-2a and 4-2b; variogram graphs for lead appear in Figures 4-3a and 4-3b. These variogram figures represent the long and short axes of continuity for arsenic and lead. Intermediate range directions were not graphed.

For arsenic, the long axis of continuity is in the east-west direction (Figure 4-2a), with the short axis running north-south (Figure 4-2b). Both variogram graphs for arsenic exhibit a steep rise from the origin of the graph until a plateau or "sill" is reached. This indicates that variability between closely spaced samples is very high. Once the sill is reached, the graph indicates that the sample data are independent, i.e. they are randomly distributed in space.

For lead, the long axis of the lead variogram (Figure 4-3a) runs from east to west, with the short axis bearing north-south (Figure 4-3b). Variogram graphs for lead also show a steep rise to the sill, indicating high levels of variability at short distances.

The distance at which the variogram graph reaches the sill is called the range. Minimum and maximum ranges for lead were greater than for arsenic, by a factor of approximately two.

Another significant feature of both the arsenic and lead variogram graphs is the presence of a significant nugget effect (C_o). The nugget effect indicates that there is variability even at a distance of zero, demonstrating that variability may occur over very short distances. The nugget effect is also an indication of sampling and analytical error. Nugget effects of almost 30 and 40% for arsenic and lead respectively indicate a high degree of local variability amongst the soils concentrations.

4.2.2 Variogram Modeling

Using the variogram graphs, mathematical models were fit to the major and minor directional variogram graphs for each metal. The mathematical model describes the variability and correlation of the sample data as the distance between samples increases. This correlation is used in the kriging process. Numerous types of mathematical equations are available for variogram modeling. For both arsenic and lead variograms, the commonly used spherical model was selected to represent the graphs. Table 4-2 lists the variogram models selected for the long and short axes of spatial continuity and the direction of these axes. The equation for the spherical model appears below:

$$\gamma(h) = C_o + C\left[\frac{3}{2}\frac{h}{a} - \frac{1}{2}\frac{h^3}{a^3}\right]$$

g(h) = variance at distance h
C_o = nugget effect
C = spherical component
a = range of influence
Sill = $C_o + C$

Table 4-2 Variogram Models

CONTAMINANT	VARIOGRAM PARAMETERS						
	C_O (mg/kg)^2	C (mg/kg)^2	Sill (mg/kg)^2	a_{min}	Direction	a_{max}	Direction
Arsenic	**200**	**525**	**725**	**30m**	**N-S**	**50m**	**E-W**
Lead	**4,500**	**7,000**	**11,500**	**70m**	**N-S**	**85m**	**E-W**

The variogram models show both similarities and differences between the spatial correlation structure for arsenic and lead. Both models indicate high variability at short distances, between 30 and 85 meters (m) or about 100 to 275 feet (ft). These are the maximum extents of the correlation structures. This means that similarity between samples is severely limited when put in the context of the VB/I-70 regional area.

A range of 100 ft indicates that probably only one to two adjacent properties show similar soils concentrations for arsenic. Beyond one or two adjacent properties, soils concentrations are random. A range of 275 ft indicates that perhaps four or five adjacent properties show somewhat similar soils concentrations. Beyond 275 ft, soils concentrations are random. With ranges between 100 and 275 ft, the similarity in soils concentrations is limited. At the low end, what could be called "neighbor-to-neighbor" similarity exists. On the high end, similarity exists only on an "intra-neighborhood" scale, but does not extend to a larger "inter-neighborhood" scale.

Variogram graphs at the VB/I-70 site do not exhibit structures similar to those found at other environmental sites that have sources of contamination where wind is a significant dispersion mechanism. For example, lead smelters typically show very high concentrations close to the smelter, combined with down-wind contamination dispersion. In such cases, the variogram graphs tend to rise very quickly from the origin (with little or no nugget effect) for a short distance, then rise more gradually for a longer distance (Myers 1985), sometimes up to one mile. This type of structural feature was not observed in the spatial structure of either arsenic or lead at the VB/I-70 site. However, data are lacking in the area of the potential historical point sources. Availability of such data could potentially alter the structure of the variogram graphs.

Also, ranges observed around other smelter locations were much larger than those observed at the VB/I-70 site. At the Dallas Lead Smelters (Myers 1985), ranges for both smelters were approximately one mile. This is approximately 20 times the range of spatial correlation observed at the VB/I-70 site.

4.3 Kriging

Kriging is a spatial estimation technique that produces regionalized views of contaminant concentrations and other variables. Kriging is a type of contouring method that can be effectively used in recognizing and detecting trends over relatively large areas. Whereas classical statistical techniques focus on individual point data with no spatial reference, kriging incorporates the unique spatial qualities of the data distribution to create useful visual displays. Used in combination with the variogram, kriging provides a powerful method for maximizing the amount of information that can be gleaned from a data set.

The block maps shown in Figures 4-4a and 4-4b show several distinct features. On the arsenic map, numerous, small areas of soils concentrations greater than 300 mg/kg are displayed. These areas are widely distributed and fairly randomly scattered. Distinct lineations are not present, nor are features resembling concentric bands of decreasing concentrations as one moves away from the former smelter areas. Such concentric banding is common around former smelters (Myers 1985; EnviroGroup, 1997). This suggests that the emplacement mechanism for arsenic did not occur on a regional scale, but rather took place in random, isolated pockets of the site.

Figure 4-4b shows the lead concentrations at the site. In contrast to the arsenic map, the lead map shows a more spatially structured nature to the contamination. Soil lead concentrations closest to the former smelters are generally the highest concentrations, with a relatively systematic decrease in soil lead values as one moves away radially from the area of the former smelters. Areas of high local variability are also present in numerous areas.

Due to the distinctly different spatial patterns exhibited by arsenic and lead in the surface soils, it appears that the two contaminants may have been emplaced by means of different mechanisms, one largely random, the other a more continuous spatial pattern.

4.3.1 Features of Kriging

Kriging offers many advantages over other estimators. Among these include the fact that, statistically, kriging is a best linear unbiased estimator (BLUE). A BLUE simply means that the estimation is done with the minimum amount of error, a highly desirable quality. Other BLUEs exist in statistical analysis, including the well-known linear regression equation. Kriging is a BLUE that has been specially adapted to handle spatial data estimation. As indicated, kriging is also unbiased, meaning that the technique does not systematically over- or underestimate the soils contaminant concentrations, another valuable characteristic.

Kriging uses variogram models, such as those in Table 4-2, to optimize the estimation and to minimize the estimation errors. During the kriging process, the kriging program searches for samples that are closest to the unsampled area being estimated. Kriging recognizes that samples closest to the area being estimated should be given more weight than samples further away. The kriging program calculates the optimal weighting system for the available samples and derives an optimal estimate of the arsenic or lead concentration at the unsampled location.

Kriging is a contouring technique, and as with all contouring techniques, tends to smooth the data. Thus, to varying degrees, all concentration ranges are smoothed. This can be beneficial when looking for regional trends in concentrations, such as arsenic and lead levels in soils. The smoothing effect helps to accentuate linear and radial structures so that they may be better seen and interpreted.

4.3.2 Kriging Application

The kriging performed for both arsenic and lead at the VB/I-70 site was done using Ordinary kriging of block areas. Block kriging integrates the estimate of the metal concentration over the area of the block. Blocks used for kriging measured 5 x 5 meters in all areas of the site for both arsenic and lead. Each block represents 25 square meters in area, or approximately 30 square yards.

Visual representations of the block kriging estimates for arsenic can be seen in Figure 4-4a. Each block has been shaded with a color representing the estimated average concentration over the block area. Six concentration categories (mg/kg), which incorporate the method detection and practical quantitation limits, have been established for the arsenic map display: Less than 11 or unsampled (shown in white), 11 to 36 (blue), 36 to 100 (green), 100 to 200 (yellow), 200 to 300 (orange), and greater than 300 (magenta). A similar representation of block concentrations for lead can be seen in Figure 4-4b, where the concentration categories (mg/kg) correspond to the values of less than 52 (white), 52 to 173 (blue), 173 to 300 (green), 300 to 400 (yellow), 400 to 500 (orange), and greater than 500 (magenta).

4.3.3 Kriging Results

Geostatistical analyses have demonstrated marginal levels of spatial continuity for both arsenic and lead in surface soils at the VB/I-70 site. Spatial continuity for lead was greater than for arsenic, but neither metal exhibited spatial correlation beyond local neighborhood areas. This type of spatial structure is generally inconsistent with point source emplacement of contamination.

The kriged geostatistical model for arsenic indicates a high degree of randomness spatially, suggesting that contaminant emplacement was random on a local basis and not caused by a point source that influenced a relatively larger region. The kriged geostatistical model for lead indicates elements of both random emplacement and regional emplacement from a point source. A lack of data in critical areas prevents the construction of a complete picture that would include information close to potential historic point sources.

4.4 Summary

Geostatistical analyses indicate that arsenic concentrations are below 36 mg/kg over most of the site; values greater than 300 mg/kg occur at a few scattered location across the site. Lead concentrations range from non-detect to over 1,100 mg/kg but tend to follow a different spacial distribution than arsenic. Correlation analysis indicates that knowing the concentration of either arsenic or lead provides very little information regarding the concentration of the other. Variogram models indicate high variability at short distances. Variogram graphs for the site do not exhibit structures found at other environmental sites where sources of contamination are dispersed by wind. The kriged geostatistical models indicate a high degree of randomness spatially, suggesting that contaminant emplacement was somewhat random and on a local basis, rather than being caused by a point source that influenced a relatively larger region. The kriged geostatistical model for lead suggests a greater type of regional influence from the smelter sites, but the evidence is inconclusive due to large areas that were not sampled.

Section Five

5.0 BASELINE HUMAN HEALTH RISK ASSESSMENT

The USEPA conducted a baseline human health risk assessment (USEPA 2001c) to characterize the risks to humans potentially exposed to contaminated soils at the site now and in the future. The risks are characterized assuming that no actions are taken to reduce human contact with contaminated soils.

5.1 Data Selected For Use in This Risk Assessment

The data from the Phase III sampling program were selected for use in this risk assessment because 1) all Phase III data were collected in accordance with project plans that were developed with careful consideration of the Data Quality Objectives (DQOs) needed to support risk assessment calculations, and 2) all data collected during Phase III are accompanied by thorough Quality Assurance (QA) data that allow detailed evaluation of the reliability of the data. A detailed review of these quality assurance data reveal that the data collected are of high quality, with adequate accuracy and precision to support a reliable evaluation of human health risk.

Data collected during Phase I/Phase II were not used because they were collected only with the intent of identifying locations that exceeded the removal action levels, and were not intended to support risk calculations or remedial decision making. More specifically, data from Phase I/Phase II were not used because 1) many samples had elevated detection limits for arsenic, 2) the sampling density at each property was too low, and/or 3) sampling locations were not clear. However, despite these limitations, it is clear that the data from Phase I/Phase II and from Phase III are generally similar, each indicating the occurrence of scattered properties with elevated levels of lead and/or arsenic.

5.2 Exposure Assessment

Figure 5-1 presents a conceptual model showing the main pathways by which contaminants present in surface soil may come into contact with area residents. This conceptual model was developed in consultation with local community groups as well as representatives from the City and County of Denver, the Colorado Department of Public Health and Environment, and the Agency for Toxic Substances and Disease Registry. Exposure scenarios that are considered most likely to be of concern are shown by boxes containing a solid circle, and greatest attention is focused on these pathways. Pathways which are judged to contribute only occasional and minor exposures are shown by boxes with an open circle. Incomplete pathways (i.e., those which are not thought to occur) are shown by open boxes. Based on this conceptual model, the pathways in Table 5-1 are judged to be of sufficient potential concern to warrant quantitative exposure and risk analysis.

Table 5-1 Exposure Pathways of Potential Concern for Quantitative Risk Analysis

Population	Medium and Exposure Route
Resident	Incidental ingestion of soil and dust in and about the home and yard Ingestion of homegrown vegetables

Other exposure pathways are judged to be sufficiently minor that further quantitative evaluation is not warranted.

5.3 Quantification of Exposure and Risk from Arsenic

5.3.1 Quantification of Exposure

It is expected that different individuals who live in the VB/I-70 site will have a range of different exposure levels to arsenic. This is because they have different intake rates of soil, dust and vegetables, and live in areas of differing arsenic concentration. The risk assessment estimated the exposure for two different types of resident: a resident with average exposure, and one at the high end of the exposure distribution. These two cases are referred to as Central Tendency Exposure (CTE) and Reasonable Maximum Exposure (RME). Estimates of exposure for the CTE and RME cases were calculated for three different exposure scenarios: long-term (chronic/lifetime) exposure of residents, short-term (subchronic) exposure of children, and acute exposure of children with behavior that is associated with very high intakes of soil known as "soil pica" behavior. The incidence of soil pica behavior in the general population is not known, but is thought to be very low. Standard exposure equations identified in USEPA risk assessment guidance were used in all cases. When applicable, EPA defaults were used for exposure parameter input values. In accord with Agency guidelines, when reliable site-specific exposure data were available, these data were used in place of default exposure assumptions. All concentration values in soil, dust and garden vegetables were based on site-specific measurements.

5.3.2 Toxicity Assessment

The toxic effects of arsenic have been reasonably well established, based mainly on studies of humans exposed to elevated levels of arsenic from a variety of sources. The findings from these studies are summarized briefly below.

Acute Noncancer Effects

Very high doses of arsenic may cause acute lethality, but such exposures from environmental sources are very unlikely. Oral exposure to non-lethal but high acute doses of arsenic produces marked irritation of the gastrointestinal tract, leading to nausea and vomiting. Other signs may include neuritis and vascular effects.

Subchronic Noncancer Effects

Symptoms resulting from sub-chronic ingestion of lower doses of arsenic often begin with a vague weakness and nausea. As exposure continues, symptoms become more characteristic and may include signs such as diarrhea, vomiting, anemia, injury to blood vessels, damage to kidney and liver, and impaired nerve function that leads to "pins and needles" sensations in the hands and feet.

Chronic Noncancer Effects

Chronic exposure to arsenic is associated with all of the effects noted above. In addition, after exposure continues for a sufficient period of time, an unusual pattern of skin abnormalities, including dark and white spots and a pattern of small "corns" may occur, especially on the palms and soles.

Carcinogenic Effects

There is strong evidence from a number of human studies that oral exposure to arsenic increases the risk of skin cancer. The most common type of cancer is squamous cell carcinoma, which appears to develop from some skin corns. In addition, basal cell carcinoma may also occur, typically arising from cells not associated with the corns. Although these cancers may be easily removed, they can be painful and disfiguring and can be fatal if left untreated. More recent data indicate that chronic oral arsenic exposure also increases the risk of several types of internal cancer, including cancer of the bladder and lung.

Toxicity Factors for Arsenic

Based on the available toxicity data for arsenic, the USEPA has established both a Reference Dose (RfD) for evaluating risk of non-cancer effects, and a cancer slope factor for quantifying the risk of cancer. These values are summarized in Table 5-2.

Table 5-2 Ingested Arsenic Toxicity Factors Utilized in the Risk Assessment

Toxicity Factor	Value	Source
Acute RfD	0.015 mg/kg-day	USEPA 2001b
Subchronic RfD	0.006 mg/kg-day	USEPA 1995
Chronic Reference Dose	0.0003 mg/kg-day	IRIS 2000
Oral Slope Factor	1.5 $(mg/kg\text{-}day)^{-1}$	IRIS 2000

Because the oral RfD and the oral SF for arsenic are based on studies of humans exposed to arsenic either in drinking water or in other readily absorbable forms, solid forms of arsenic in site soils may be less well-absorbed and require adjustments in the toxicity factors to derive appropriate estimates of toxicity. In order to investigate the relative bioavailability (RBA) of arsenic in site soils, USEPA performed a study in which five separate samples were fed to swine for 12 days. The study found that arsenic in site soils was less well absorbed than a readily soluble form of arsenic (sodium arsenate), with RBA values for individual samples ranging from about 0.18 to 0.45. Based on the results of this study, the upper confidence limit of the RBA for arsenic in site soils was estimated to be 0.42.

5.3.3 Risk Characterization for Arsenic

5.3.3.1 Risks from Soil and Dust

Cancer Risk

Cancer risks from exposure of residents to arsenic in yard soil and indoor house dust were calculated for each property using the basic equations recommended by USEPA. The risk estimates are expressed as the probability that an individual exposed to arsenic at the site will develop a cancer by the age of 70 that would not otherwise have occurred. For example, a cancer risk of 2E-05 means that the probability is 2 out of 10^5 (2 out of 100,000) that the exposed individual might develop a tumor from site-related exposures. The results of these calculations are shown in Table 5-3.

For CTE exposure conditions, most properties have estimated excess cancer risks for exposures due to arsenic in soil plus dust that range from 1E-06 to 1E-05 (5th to 95th percentiles), with a maximum value of 9E-05. For RME exposure conditions, most properties have risks that range from 9E-06 to 1E-04 (5th to 95th percentiles), with 92 properties having risks greater than 1E-04. The highest RME risk value was 8E-04. The spatial pattern of properties with arsenic RME cancer risk levels greater than 1E-04 is approximately uniform across the site, with a frequency of about 1%-4% in each neighborhood.

When interpreting these risk estimates, it is important to recognize that arsenic is a naturally occurring element in soil. Based on an analysis of the distribution of concentration values observed in Phase III soil samples, it is estimated that background levels are well-characterized as a lognormal distribution with a mean of 8 ppm and a standard deviation of 3.6 ppm. Based on this, background levels may range up to about 15 ppm or slightly higher. If so, lifetime cancer risks from naturally occurring levels of arsenic probably range from about 1E-06 for an average (CTE) person up to about 1E-05 for an upper-bound (RME) individual.

Table 5-3 Estimated Cancer Risk from Arsenic in Soil and Dust

Neighborhood	Number of Properties Evaluated	Number and Percent of Properties Within the Specified Risk Range							
		CTE Cancer Risk				RME Cancer Risk			
		<=1E-05	2E-05 - 1E-04	2E-04 - 1E-03	> 2E-03	<=1E-05	2E-05 - 1E-04	2E-04 - 1E-03	> 2E-03
Clayton	902	858	44			479	385	38	
		95%	5%			53%	43%	4%	
Cole	796	772	24			344	429	23	
		97%	3%			43%	54%	3%	
Elyria	59	58	1			17	41	1	
		98%	2%			29%	69%	2%	
Five Points	27	26	1			5	21	1	
		96%	4%			19%	78%	4%	
Globeville	63	61	2			25	36	2	
		97%	3%			40%	57%	3%	
Swansea	1166	1132	34			610	528	28	
		97%	3%			52%	45%	2%	
All Neighborhoods	2986	2881	105			1475	1419	92	
		96%	4%			49%	48%	3%	

CTE=Central Tendency Estimate
RME=Reasonable Maximum Exposure

Chronic Noncancer Risks
In accord with standard EPA methods, the risk of non-cancer effects is expressed as the ratio of the dose resulting from exposure to site media compared to a dose that is believed to be without risk of effects, even in sensitive individuals. This ratio is called the Hazard Quotient (HQ). If the value of HQ is equal to or less than one (1), it is believed there is no significant risk of noncancer effects. If the HQ exceeds one, then there is a chance that noncancer effects may occur, with the probability tending to increase as the value of HQ increases.

Estimated risks of non-cancer health effects from chronic exposure to arsenic in soil and dust are shown in Table 5-4. For individuals with CTE exposure, risks at most properties fall between 0.02 and 0.2 (5th to 95th percentile), while individuals with RME exposure have risks that lie mainly between 0.05 and 0.6. These results indicate that risk of noncancer effects from chronic exposure is below a level of concern for most individuals at most locations. However, a total of 20 properties have RME HQ values greater than 1, with a maximum value of 4. These locations where noncancer risks enter a range of concern (HQ > 1) are also above the usual level of concern (1E-04) for cancer.

Table 5-4 Estimated Chronic Noncancer Risk from Arsenic in Soil and Dust

Neighbor-hood	Number of Properties Evaluated	Number and Percent of Properties Within the Specified Risk Range							
		CTE Hazard Quotient				RME Hazard Quotient			
		#1	2-5	6-10	>= 11	#1	2-5	6-10	>= 11
Clayton	902	901	1	--	--	895	7	--	--
		100%	0.1%	--	--	99%	0.8%	--	--
Cole	796	796	0	--	--	786	10	--	--
		100%	0%	--	--	99%	1.3%	--	--
Elyria	59	59	0	--	--	59	0	--	--
		100%	0%	--	--	100%	0%	--	--
Five Points	27	27	0	--	--	27	0	--	--
		100%	0%	--	--	100%	0%	--	--
Globeville	63	63	0	--	--	63	0	--	--
		100%	0%	--	--	100%	0%	--	--
Swansea	1166	1166	0	--	--	1163	3	--	--
		100%	0%	--	--	100%	0.3%	--	--
All Neighbor-hoods	2986	2985	1	--	--	2966	20	--	--
		100%	0%	--	--	99%	0.7%	--	--

CTE=Central Tendency Estimate
RME=Reasonable Maximum Exposure

Noncancer Risks from Short-Term Exposures
Estimated risks of non-cancer health effects from sub-chronic exposure of area children to arsenic in soil are shown in Table 5-5. As seen, the incidence of properties with subchronic HQ values above 1 is relatively low (2 out of 2,986 = 0.07% for CTE individuals, 53 out of 2,986 = 1.8% for RME individuals). The maximum RME HQ value was 7. All of the locations where subchronic noncancer risks enter a range of concern (HQ > 1) are also above the usual level of concern (1E-04) for cancer.

Table 5-5 Estimated Subchronic Noncancer Risks from Arsenic in Soil

Neighbor-hood	Number of Properties Evaluated	Number and Percent of Properties Within the Specified Risk Range							
		CTE Hazard Quotient				RME Hazard Quotient			
		#1	2-5	6-10	>=11	#1	2-5	6-10	>=11
Clayton	902	900	2			881	19	2	
		100%	0.2%			98%	2%	0.2%	
Cole	796	796	0			777	19	0	
		100%	0%			98%	2%	0.0%	
Elyria	59	59	0			58	1	0	
		100%	0%			98%	2%	0.0%	
Globeville	63	63	0			62	1	0	
		100%	0%			98%	2%	0.0%	
Swansea	1166	1166	0			1155	11	0	
		100%	0.0%			99%	1%	0.0%	
All	2986	2984	2			2933	51	2	
		100%	0.1%			98%	2%	0.1%	

Acute Noncancer Risks from Soil Pica Behavior

Because of the substantial uncertainty which exists in most of the input parameters for the acute pica scenario, it is not possible to specify a single set of inputs that are "best." Rather, a range of HQ values were calculated for two different combinations of soil intake and RfD values:

Variable	Case 1		Case 2	
	CTE	RME	CTE	RME
Soil intake (mg/day)	5000	10000	2000	5000
Acute RfD (mg/kg-d)	0.005		0.015	

Case 1: RfD = 0.005 mg/kg; Pica intake = 10,000 mg
Case 2: RfD = 0.015 mg/kg; Pica intake = 5,000 mg

It should be understood that these cases represent an uncertainty range, and that the "true" acute risk from pica behavior could lie anywhere in the interval. Indeed, it is quite possible that the true value even lies outside the range, since the actual distribution of pica soil intakes is not known.

The results are summarized in Table 5-6. As seen, the screening calculations above suggest that a large number of properties (ranging from 662 to 1841, depending on which set of input assumptions is deemed to be most appropriate) are of potential concern for the RME acute pica scenario.

Given that discussions are continuing to occur nationally on the most appropriate acute RfD for arsenic and in the absence of reliable data on the magnitude of soil pica intake, it is difficult to judge which (if any) of these properties should be considered to be an authentic acute health risk to children. In this regard, it should be noted that even though many people are exposed to arsenic levels in soil that are predicted to be of acute concern, both within the VB/I-70 site and elsewhere across the country and around the world, to the best of USEPA's knowledge, there has never been a single case of acute arsenic toxicity reported in humans that was attributable to arsenic in soil. Thus, these results for the acute pica scenario are considered to be especially uncertain, since they predict a very substantial risk for which there is no corroborating medical or epidemiological evidence.

Table 5-6 Estimated Acute Noncancer Risks from Pica Behavior

Exposure Assumptions	Number and Percent of Properties within the Specified Risk Range									
	CTE Hazard Quotient					RME Hazard Quotient				
	#1	2-5	6-20	> 20	Total > 1	#1	2-5	6-20	> 20	Total > 1
Case 1	1475	949	432	130	1511	1145	580	328	933	1841
	49%	32%	14%	4%	51%	38%	19%	11%	31%	62%
Case 2	2692	268	26	0	294	2324	487	162	13	662
	90%	9%	1%	0%	10%	78%	16%	5%	0%	22%

5.3.3.2 Risks from Homegrown Vegetables

A total of 72 different samples of garden vegetables was collected from 19 different properties across the site. At each property, the 95% upper confidence limit (UCL) of the mean concentration of arsenic was calculated, and this value (or the maximum, whichever was lower) was used to estimate risks to residents. For individuals whose intake of homegrown garden vegetables is average (CTE) for the western United States, neither non-cancer nor cancer risks enter a range of concern at any property tested. For individuals whose intake is at the upper-bound (RME) of the distribution of garden vegetable consumption, cancer and non-cancer risks do enter a range of potential concern for two properties. However, these risks were driven either by a single value that appeared to be anomalous, or by the margin of safety introduced by use of the 95% UCL. Overall, it appeared that while risks from arsenic in garden vegetables could not be entirely excluded, the risks were likely to be low. This is supported by noting that the intake of arsenic from homegrown vegetables is predicted to be well within the normal dietary range observed in the United States.

5.3.3.3 Total Risks from Ingestion of Soil and Homegrown Vegetables

As noted above, data on arsenic levels in soil are available for all 2,986 properties investigated in Phase III, but data on arsenic levels in gardens and vegetables were collected only at 19 of these properties. Therefore, in order to calculate total risk at all properties, it was necessary to estimate the concentration of arsenic in garden vegetables using site-specific data on the relationship between arsenic in yard soil and in garden soil, and between arsenic in garden soil and in vegetable tissues.

Because exposure and risk from soil ingestion and vegetable ingestion are both distributions, care must be taken in the summation process. In the case of the non-cancer or cancer risk to an individual who has average exposure to both soil and vegetables, the total risk is simply the sum of the two pathway-specific risks:

$$\text{CTE(total)} = \text{CTE(soil)} + \text{CTE(vegetables)}$$

In the case of an individual who has RME exposure to soil or to vegetables, the estimate of RME total risk is not the simple sum of the RME risk estimates, because the two pathways are independent of each other, and an individual with RME soil intake is not likely to also have RME vegetable intake (and vice versa). Thus, the estimate of RME total risk is calculated either as:

1: RME(total) = RME(soil) + CTE(vegetables)
2: RME(total) = CTE(soil) + RME(vegetables)

The results are shown in Table 5-7. As seen, based on the site-specific relationships between arsenic in yard soil and garden soil and between arsenic in garden soil and garden vegetables, individuals with CTE exposure to garden vegetables are predicted to have excess cancer risks that are less than or equal to 1E-05, while individuals that have RME intake of garden vegetables are expected to have risks mainly between 2E-05 and 1E-04, with only a few properties having risks that exceed 1E-04. When CTE risks are combined across pathways, there are 65 properties where total risk exceeds 1E-04. When RME risks are combined across pathways, the highest risks occur for case 1 (RME soil intake plus CTE vegetable intake). Based on this scenario, there are 99 properties where total RME risks exceed 1E-04.

Table 5-7 Estimated Total Cancer Risks from Soil and Vegetables

Statistic	Pathway	Number of Properties		
		<= 1E-05	2E-05 to 1E-04	2E-04 to 1E-03
CTE Risk	Soil alone	2881	105	
	Vegetables alone	2986		
	CTE Soil + CTE vegetables		2921	65
RME Risk	Soil alone	1475	1419	92
	Vegetables alone		2979	7
	RME Soil + CTE vegetables[a]	933	1954	99
	CTE Soil[a] + RME vegetables		2921	65

[a] Adjusted to account for RME exposure duration (30 years)

5.3.4 Uncertainties in Arsenic Risk Assessment

It is important to recognize that the calculations of short-term and long term exposure and risk from arsenic ingestion in soil are based on a number of assumptions and estimates, and that these introduce uncertainty into the risk results. The most important of the sources of uncertainty in the calculations are summarized below.

Uncertainty in Average Concentration Terms

The concentration term that is appropriate for calculating chronic exposure and risk from ingestion exposure to arsenic is the true mean concentration in the medium of concern (soil, dust, vegetables), averaged over the area and time interval (averaging time) of concern. There are two important sources of uncertainty in this value. First, because the true mean cannot be calculated from a limited set of sample results, the USEPA utilizes the 95% upper confidence limit of the mean as a conservative estimate of the true mean. This approach helps ensure that the exposure and risk estimates that are derived are more likely to overestimate than underestimate the actual risk. Second, the basic exposure unit selected for evaluation in this risk assessment is the residential property. Using the UCL of the mean for a property is equal to assuming that an individual residing at that location does not ingest soil or dust from any other location, even over a time period of up to 30 years. While this might be true for a small sub-set of residents, it is believed that most residents are sufficiently mobile that exposures will occur over a wider area than just their own yard. This, in turn will result in lower exposures for people residing in homes with impacted soils, and their true risks will be lower than calculated.

Uncertainty in Concentration Values at Sublocations

As noted earlier, the sampling and analysis design for Phase III was based on a set of three composite samples from each property. Consequently, there are no data that allow a direct estimation of the concentration value at any specific sub-location of the yard (these are needed to address risks from subchronic and acute exposures). To address this data limitation, the distribution of concentration values within a property was modeled by assuming a lognormal distribution, and the standard deviation within each property was estimated from a site-wide average coefficient of variation. Since the mean at each property was estimated using the 95% UCL or the maximum composite value, both the mean and the standard deviation are more likely to be high than low at each property. Thus, the values estimated for evaluation of subchronic and acute exposures are also more likely to be high than low.

Uncertainty in Intake Rates

Data on the amount of soil ingested by humans are very limited. Measurements are difficult to perform, and results vary significantly from study to study and from method to method. In addition, data are based mainly on short term studies, so estimates of long-term average intake rates are especially uncertain. Moreover, intake rates are likely to vary from site to site and property to property, depending on things such as climate, socioeconomic status, yard condition, etc., so the default intake rates used in these calculations may not reflect the true intake rates at the site. Because of the limitations in the data, the default values recommended by USEPA are intended to be on the high side (i.e., are more likely to overestimate than underestimate actual soil ingestion).

This is illustrated by comparing the default soil intake rates used by USEPA to data on soil intake rates measured in a group of 64 children in Anaconda, Montana (Stanek and Calabrese 2000). This study, which utilizes the latest and most refined analytical and statistical methods for estimating soil ingestion by children, estimated that the average (CTE) 7-day intake by children is about 31 mg/day (compared to the default of 100 mg/day), and that the 95th percentile intake for 7 days and 365 days are 133 and 106 mg/day, respectively (compared to the default assumption of 200 mg/day). If these values from the Anaconda site were judged to be a more reliable basis for estimation of risk from soil ingestion than the current default values, and if adult soil intake is assumed to be about ½ that of children, then there are only 23 properties (rather than 92 properties) in the VB/I-70 site where RME cancer risks from soil ingestion exceed a level of 1E-04.

Uncertainty in the Fraction of Total Intake that is Soil

One of the variables used to calculate risks from ingestion of soil plus dust is the fraction of the total intake that is soil (f_s). The EPA default value for this variable (45%) is based mainly on measurements in a set of 64 preschool children, but due to the difficulty in making these measurements, as well as potential differences between children and between sites, this value should be considered uncertain. It is not known whether the true value at the VB/I-70 site is more likely to be higher or lower than the default values. If the true site-specific value of f_s were lower (e.g., 20% rather than 45%), risks would be about 12% lower than calculated. Conversely, if the true site-specific value were higher (e.g., 70% rather than 45%), then the risks would be about 12% higher than calculated.

Uncertainty in Exposure Duration

Cancer risk calculations depend on the duration of exposure. Default exposure durations used in the risk assessment are not site-specific, and are estimated from data on the length of time that people own a particular residence. Thus, actual exposure durations of residents at the site may not be the same as the assumed exposure durations, and might be either longer or shorter than assumed. For example, if the exposure duration were assumed to be 45 years (6 years as a child and 39 years as an adult) rather than the default value of 30 years, the estimated excess cancer risk level from soil ingestion would be about 19% higher than the values reported. In addition, all of the exposure calculations presented here assume that exposure begins during childhood, when intake rates are higher than during adulthood. Thus, risks to individuals who move to the site after they are children will be lower than estimated. For example, risks to an individual exposed for 30 years as an adult are only 37% of the risks to an individual exposed for 6 years as a child and 24 years as an adult.

Uncertainty in RME Exposures

In the default point estimate approach for estimating exposure and risk to an RME individual, two exposure parameters (intake rate and exposure duration) are both assumed to be at their 95th percentile values. In reality, because these two exposure parameters are independent of each other, it is very unlikely that an individual with RME soil intake will also have RME exposure duration. Therefore, an individual with both RME soil intake and RME exposure duration represents not the 95th percentile of the risk distribution, but some significantly higher percentile. One way to estimate what the percentile of the default RME individual is, as well as the actual 95th percentile value, is through Monte Carlo modeling. Screening level calculations performed with this approach suggest that the RME risk estimate derived by the point estimate approach is about twice the Monte Carlo estimate of the 95th percentile value, and is located at approximately at or above the 99th percentile of the risk distribution. This supports the conclusion that RME point estimates of risk provide a substantial margin of safety.

Uncertainty in Toxicity Factors
One of the largest sources of uncertainty in most risk assessments stems from uncertainty in the toxicity factors used to predict responses from the calculated doses. In the case of arsenic, dose-response data are derived from studies in humans, which significantly reduces the degree of uncertainty compared to extrapolations based on animal data. However, a significant degree of uncertainty still remains in both the oral cancer slope factor and the chronic RfD. One of the most important sources of this uncertainty is lack of reliable data on actual arsenic ingestion rates by the human population used to quantify risk. There are also still large uncertainties in how to extrapolate the dose-response curve from relatively high exposure levels to lower exposure levels. For example, arsenic does not appear to cause cancer by a direct genotoxic mechanism (USEPA 2001a), suggesting that a sub-linear (and perhaps even a threshold) model might be reasonable. However, in the absence of information on the actual mode of action, an assumption of linearity is still deemed to be necessary and appropriate (USEPA 2001a). If the dose response curve is sub-linear, current risk estimates would be too high. Further, there is uncertainty in the importance of cultural, ethnic, dietary, and socioeconomic differences between different study populations. While little is known about the relative importance of these factors, it is likely that there are differences between people in their sensitivity to ingested arsenic, and it is for this reason that USEPA seeks to ensure an adequate margin of safety in the derivation of the RfD and the slope factor.

Uncertainty in Bioavailability
In order to cause an adverse response, arsenic that is ingested must be absorbed into the body. Measurements of the arsenic relative bioavailability have been performed for five soils from the VB/I-70 site. While measurements based on site soils significantly reduces uncertainty in this exposure parameter, uncertainty still remains. For example, variability was observed between different site soils, and a conservative estimate of the mean value was employed to represent the site-wide average absorption. This approach is expected to result in an over-estimate of true absorption. Another source of uncertainty is in the extrapolation of data from test animals to humans. The test animals (swine) were selected because they are believed to have a gastrointestinal system similar to that in humans, but it is also expected that absorption in humans may vary as a function of age, stomach contents, nutritional status, etc. Thus, the measurements in animals should be viewed as uncertain estimates of the true values in humans.

The RBA measured for soil was also assumed to apply to dust. This assumption is uncertain because the size distribution of arsenic-containing particles in dust may be different than for soil, and particle size might be one factor that influences RBA. If dust contains smaller particles than soil, and if this size difference tends to increase RBA, then the use of the soil RBA could underestimate the absorption of arsenic from dust. However, it should be remembered that the RBA value for soil was measured using only the fine fraction of soil (only particles smaller than 250 micrometers in diameter), so the difference in particle size distribution between dust and soil is not expected to be large. In addition, because arsenic concentrations in dust tend to be lower than in soil, the dose contributed by dust ingestion is relatively small compared to that for soil, so uncertainty in the absorption fraction for dust results in only a small uncertainty in the total absorbed dose.

Uncertainty in Pica Exposure and Risks

As noted above, screening-level calculations suggest that acute exposures to arsenic in soil associated with soil pica behavior (i.e., pica exposure) might be of concern at a number of properties within the site. However, data on the amount of soil ingested during pica behavior are very sparse. Based mainly on one study that observed an intake of 5-8 g/day by a single child, (Calabrese et al. 1989), USEPA has indicated that 5-10 grams might be a reasonable estimate. If this intake rate is correct, and if arsenic absorption from this mass of soil is similar to that estimated in site-specific studies (42%), then anywhere from 22% to 62% of all properties within the VB/I-70 site (and perhaps outside the site as well) could have arsenic levels above a level of acute concern. USEPA feels this conclusion is especially uncertain, since the Agency is not aware of any reported cases of acute arsenic toxicity attributable to ingestion of arsenic in soil. A more recent study of soil intake did not observe intake rates above 700 mg/day in a group of 64 children, suggesting that values of 5-10 grams might be unrealistically high. In addition, limited data on urinary arsenic levels in residents of the VB/I-70 area and the nearby Globe neighborhood do not reveal the occurrence of high soil intakes by children. These considerations suggest that arsenic risk from soil pica behavior may not be as significant as the calculations suggest. On the other hand, if this type of exposure were to occur, it is possible the symptoms (transient upset stomach and general malaise) would not be recognized as being arsenic-related, and could easily go un-detected or un-reported. In addition, if soil pica behavior is assumed to occur only infrequently during childhood, then the chances of observing the behavior in a study could be quite low. Because of the high uncertainty regarding the magnitude and frequency of soil pica behavior, more reliable risk estimates for this scenario will not be possible until better data are collected on pica intakes, along with direct measures of soil-related exposures to arsenic in soil.

Summary of Uncertainties in Arsenic Risk Characterization

Because of the uncertainties summarized above, none of the exposure and risk calculations for arsenic should be interpreted as accurate measures of the true risk, rather, all values should be interpreted as uncertain estimates. Because a majority of the approaches for dealing with uncertainty are more likely to overestimate than underestimate true risk, the final risk values above should be thought of as more likely to be higher than lower than the actual risks.

5.4 Exposure Risk From Lead

5.4.1 Overview

Risks from lead exposure are evaluated using a somewhat different approach than for most other metals. First, risks are assessed only for young children because they are more susceptible to the health effects from lead exposure than adults. Second, risks are expressed as the probability that a child will have a blood lead value greater than 10 μg/dL. The health-based goal established by USEPA is that there should be no more than a 5% chance that any child will have a blood lead value above 10 μg/dL.

5.4.2 IEUBK Model for Assessing Lead Risk

5.4.2.1 Risks from Soil and Dust

The USEPA has developed an Integrated Exposure Uptake Biokinetic (IEUBK) model for predicting the likely range of blood lead levels in a population of young children (age 0-6 years) exposed to a specified set of environmental lead levels. The IEUBK model was used to predict risks at each property that was sampled during Phase III, using default IEUBK model input parameters for all parameters except for two site specific inputs: 1) the concentration of lead in dust as a function of the concentration in soil, which were based on site-specific measurements, and 2) the relative bioavailability of lead, which was based on a test of site soils in an animal study. The site specific RBA was 84%, higher than the IEUBK model default assumption of 60%.

The IEUBK model was used to calculate the expected blood lead distribution for children (age 0-84 months) for each property. The results, characterized in terms of the probability of a random child exceeding a blood lead value of 10 μg/dL (this is referred to as "P10"), are shown in Table 5-8. As seen, 1,655 out of 2,986 homes are predicted to have P10 values at or below the health-based goal of 5%, while 1,331 (45%) are predicted to exceed the health-based goal. Approximately 610 properties are predicted to have P10 values of 5-10%, slightly above the heath-based goal. However, about 518 properties would be expected to have P10 values between 10-20%, and 203 homes are predicted to have P10 values greater than 20% (substantially above the health-based goal). It should be noted that 1,057 of the 1,331 properties (79%) with P10 values above 5% have mean bulk lead concentrations lower than 400 ppm (the USEPA screening level for lead in soil). This is mainly because the site-specific RBA for lead (84%) is higher than the default value (60%), and also because of the use of the concentration value in the fine fraction rather than the bulk fraction in the risk calculations.

Although homes with elevated soil lead are found in all neighborhoods, the density of homes with P10 values greater than 5% tends to be higher in the central and western part of the site than in areas on the eastern side of the site.

When interpreting these risk estimates, it is important to recognize that lead is a naturally occurring element in soil, and that there are many current and historic anthropogenic sources of lead (e.g., automobile exhaust, leaded paint, generalized industrial emissions, etc.). Based on the extensive soil data set collected during Phase III, levels of lead in bulk soils at the VB/I-70 site range from below the detection limit (about 52 ppm) up to a maximum of more than 1,000 ppm. If it is assumed that the upper range of the lead from natural and area-wide anthropogenic sources is about 400 ppm, then the mean of all samples that are less than 400 ppm is about 195 ppm. Using this value (195 ppm in bulk soil) as a rough estimate of the mean concentration in urban background samples, and assuming the same site-specific input values described above, the IEUBK model predicts that blood lead levels attributable to urban background levels of lead probably average about 4.4 μg/dL for a typical (median) child, and might be as high as 9.5 μg/dL for a child with above-average (95th percentile) exposure to soil or dust.

Table 5-8 Estimated Risks to Children from Lead in Soil and Dust

Neighborhood	Total Number of Properties	Number and Percent of Properties within Specified Risk Range				
		P10 <= 5%	P10 > 5% and <= 10%	P10 > 10% and <= 20%	P10 > 20%	Total P10>5%
Clayton	902	712	119	52	19	190
	100%	79%	13%	6%	2%	21%
Cole	796	169	248	273	106	627
	100%	21%	31%	34%	13%	79%
Elyria	59	6	9	28	16	53
	100%	10%	15%	47%	27%	90%
Globeville	63	7	18	21	17	56
	100%	11%	29%	33%	27%	89%
Swansea	1166	761	216	144	45	405
	100%	65%	19%	12%	4%	35%
All	2986	1655	610	518	203	1331
	100%	55%	20%	17%	7%	45%

P10=Prediced Risk of Exceeding Blood Lead of 10 μg/dL

5.4.2.2 Risks from Lead in Garden Vegetables

As noted previously, site-specific data show there is essentially no detectable uptake of lead from soil into garden vegetables at this site. On this basis, it is concluded that exposure to lead from ingestion of home grown garden vegetables is not of concern.

5.4.3 Uncertainties in Lead Risk Evaluation

It is important to stress that lead risk predictions based on the IEUBK model are uncertain. This uncertainty arises from a number of factors. First, there is inherent difficulty in providing the model with reliable estimates of human exposure to lead-contaminated media. For example, exposure to soil and dust is difficult to quantify because human intake of these media is likely to be highly variable, and it is very difficult to derive accurate measurements of actual intake rates. Likewise, site-specific data on exposure to lead through the diet are generally not available, and because dietary lead levels have been decreasing over time, the default data used in the model may no longer be accurate. Second, it is often difficult to obtain reliable estimates of key pharmacokinetic parameters in humans (e.g., absorption fraction, distribution and clearance rates, etc.), since direct observations in humans are limited. Finally, the absorption, distribution and clearance of lead in the human body is an extremely complicated process, and any mathematical model intended to simulate the actual processes is likely to be an over-simplification. Consequently, IEUBK model calculations and predictions should not be thought of as being identical to actual risk.

One way to help characterize the uncertainty that may exist in the IEUBK model calculations is to investigate the effect of alternative (non-default) model inputs for some of the more uncertain parameters. Especially important is the geometric standard deviation (GSD) value, which has a very powerful effect on the number of properties of concern. Studies at other sites have shown that the GSD value may often be lower than the default of 1.6, and if that were to be the case at this site, risks to children from lead could be substantially overestimated. Another parameter that is uncertain is the soil intake rate, and if data from the most recent study of soil intake in children were used in place of the default soil intake values, risks from lead would be below a level of concern at most locations.

Another way that may sometimes help assess whether the IEUBK model is yielding reliable results at a particular site is to compare the IEUBK model predictions with actual observations of blood lead levels in the population of children currently living at the site. At the VB/I-70 site, only very limited blood lead data collected by USEPA are available, with values from only 21 individuals available (15 participants in the Phase I / II program, 6 participants in the Phase III program). In this group of individuals, the maximum blood lead concentration observed was 5 μg/dL. While this the data set is much too limited to support the conclusion that risks are absent, neither do the results signal any cause for alarm. Data from several blood lead surveillance programs conducted by the State suggest that lead in soil does contribute to blood lead in area children, but that soil lead is not the primary reason for blood lead concentrations greater than 10 μg/dL.

5.5 Conclusion

Arsenic

In some yards within the VB/I-70 site, levels of arsenic in yard soil are sufficiently elevated to pose an RME excess lifetime cancer risk that is above a level of 1E-04. Based on current data, about 3% of all properties fall into this category. Chronic and subchronic non-cancer risks from arsenic are also above a level of human health concern at some properties, mainly at the same locations where cancer risks are above 1E-04.

Screening level calculations suggest that high levels of soil intake associated with soil pica behavior in children might be of acute non-cancer concern at a large number of properties at the site, but this finding is judged to be especially uncertain due to lack of reliable information on the magnitude and frequency of pica soil ingestion and on the most appropriate acute oral RfD value.

Lead

Lead also occurs at elevated levels in soil at some residential properties. Elevations occur in all neighborhoods of the site, but levels tend to be higher on the western part of the site than the eastern part. Using EPA's IEUBK model to evaluate the risk to children, it is estimated that about 45% of residences have levels that exceed EPA's health-based goal (no more than a 5% chance that a child will have a blood lead value above 10 μg/dL). Of these, many (about 79%) have mean lead concentrations lower than 400 ppm (the USEPA default level of concern). This is mainly because the site-specific RBA for lead (84%) is higher than the default value (60%).

Section Six

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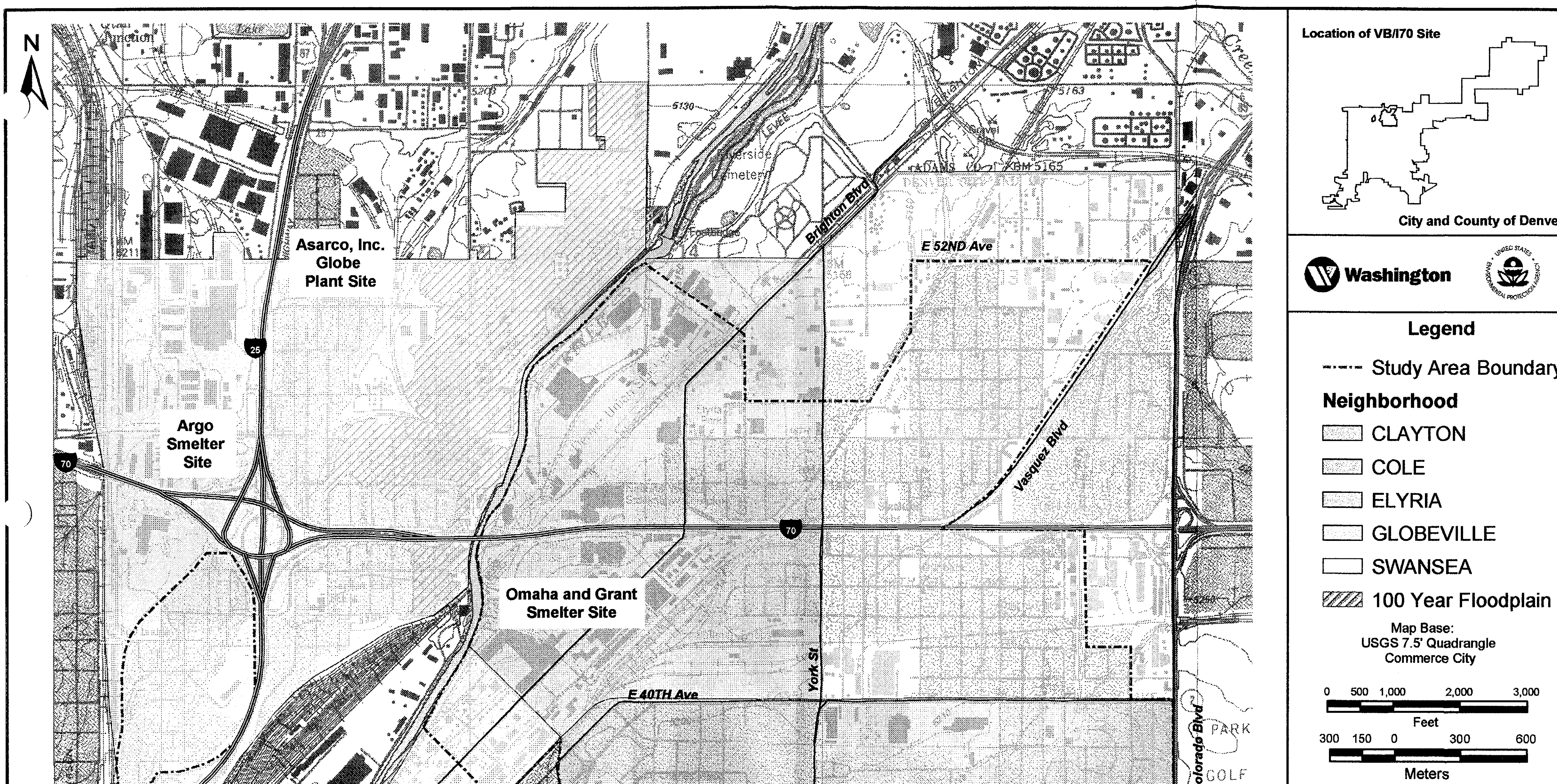
Figure



Vasquez Boulevard / I-70
Operable Unit 1
Remedial Investigation Report

Figure 1-1

Site Location

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Figure 1-2. Phase I and II
Distribution of Maximum Lead Concentrations at Residential Properties

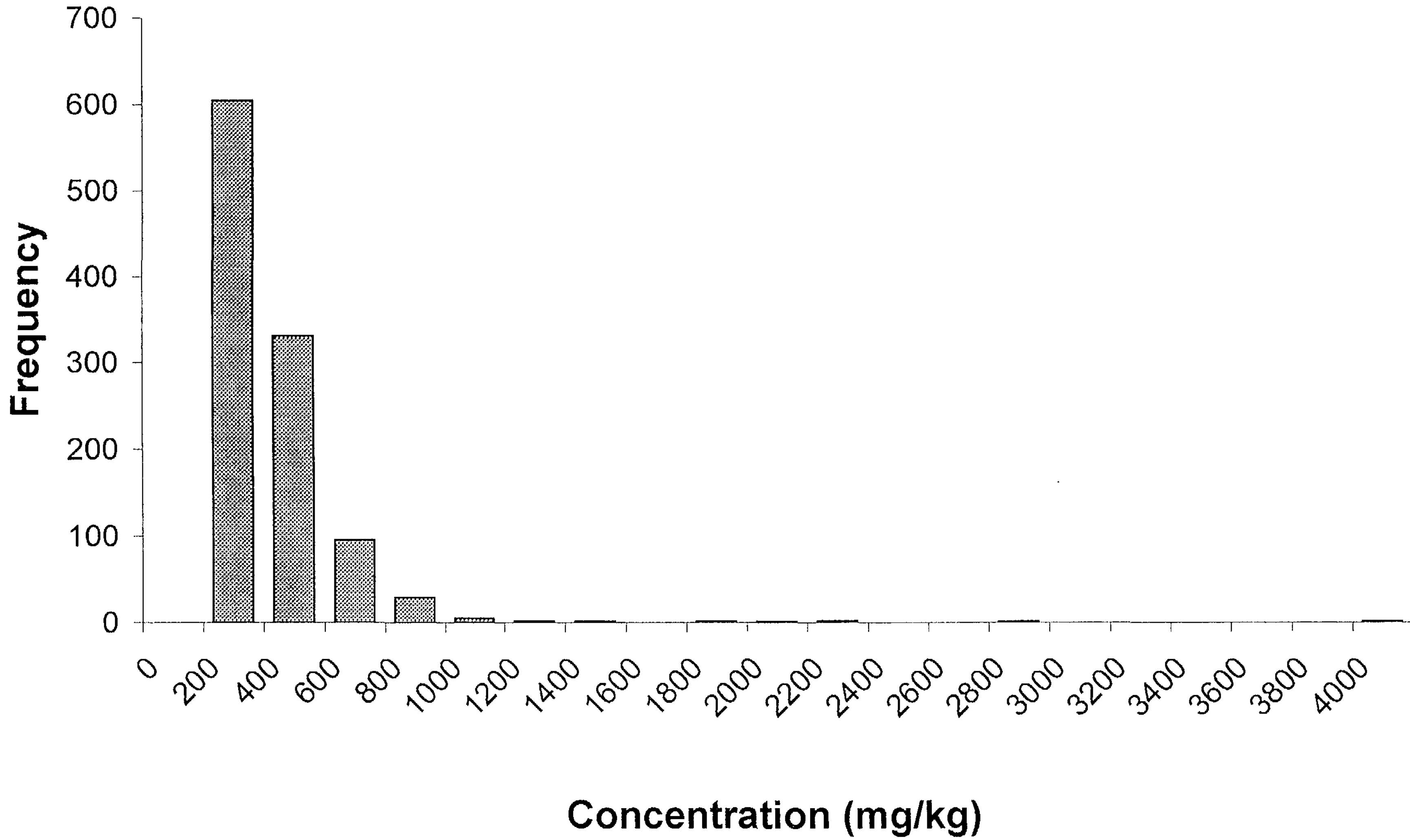

Figure 1-3. Phase I and II

Distribution of Maximum Arsenic Concentrations at Residential Properties

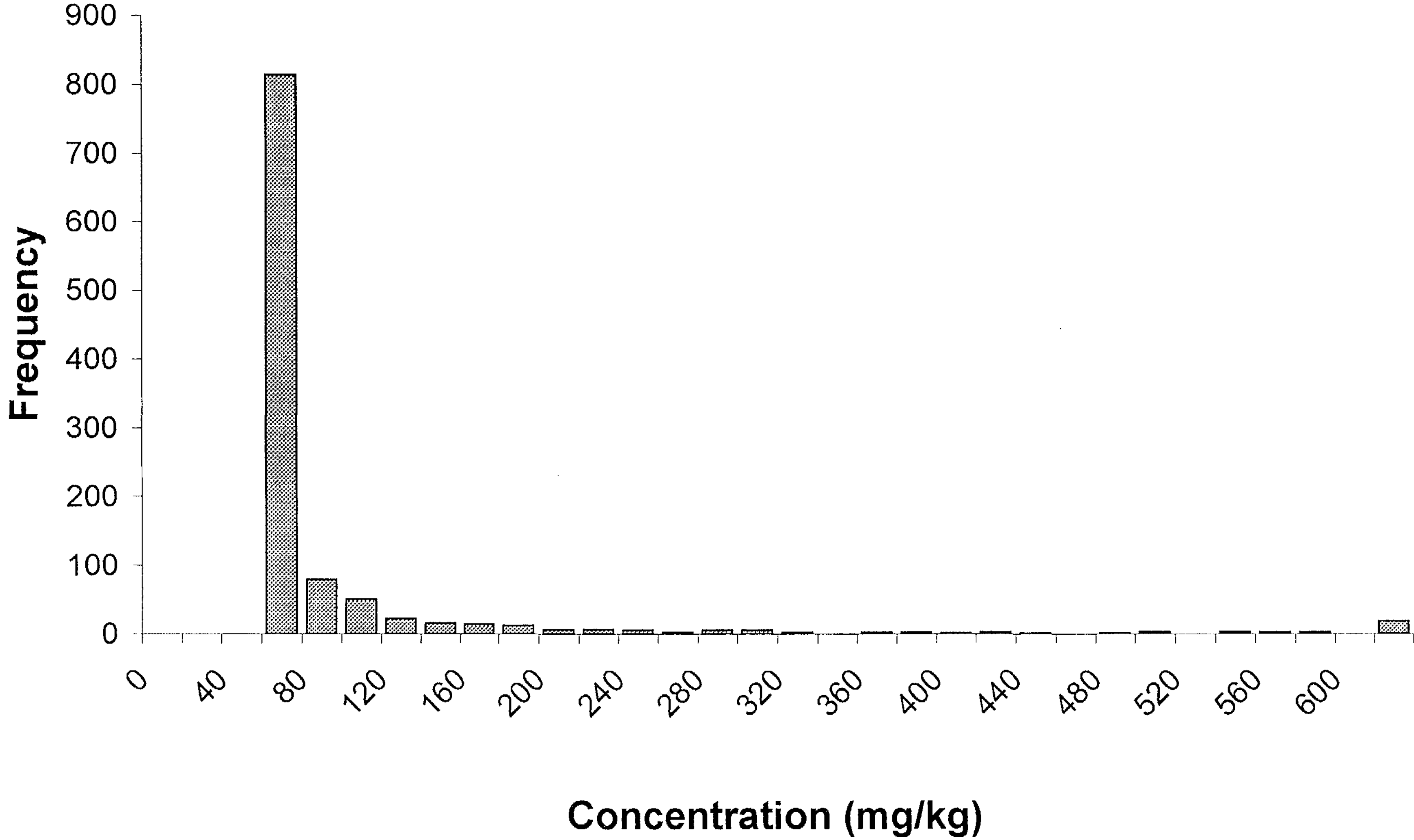

Figure 3.1-1a - Comparison of Arsenic Concentrations in 1998 Bulk Samples and Fines

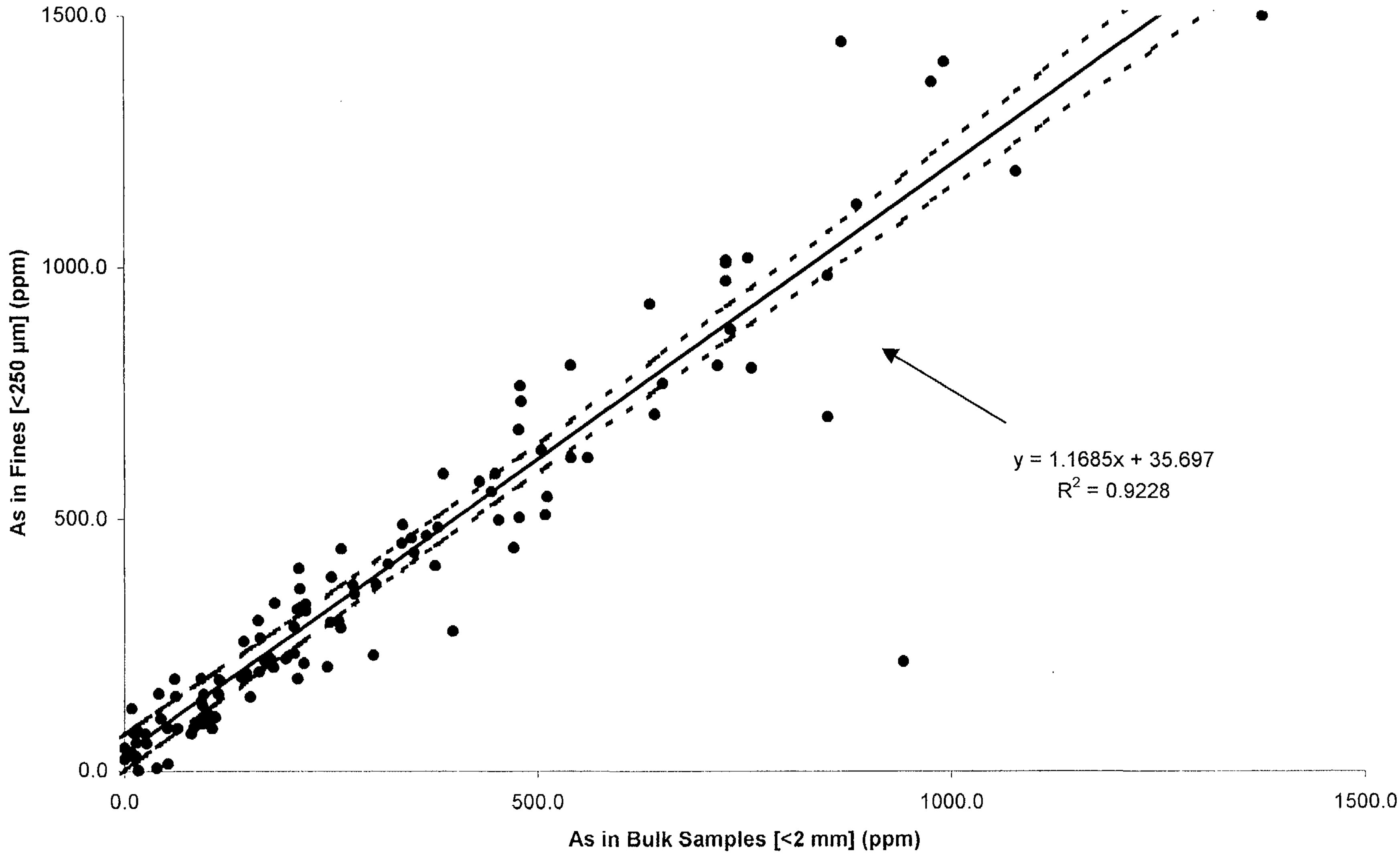

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Figure 3.1-1b - Comparison of Lead Concentrations in 1998 Bulk Samples and Fines

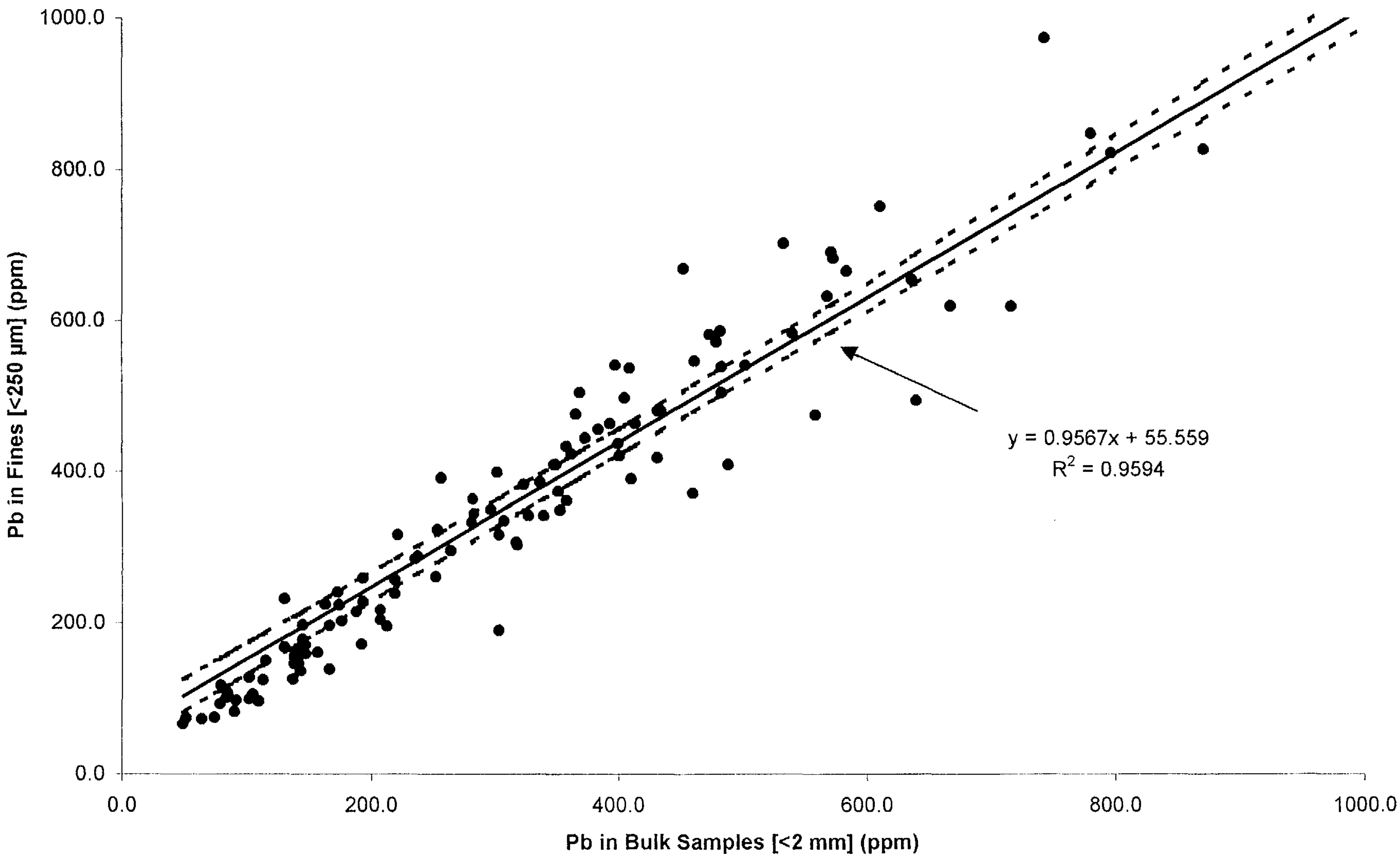

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Figure 3.1-1c - Comparison of Cadmium Concentrations in 1998 Bulk Samples and Fines

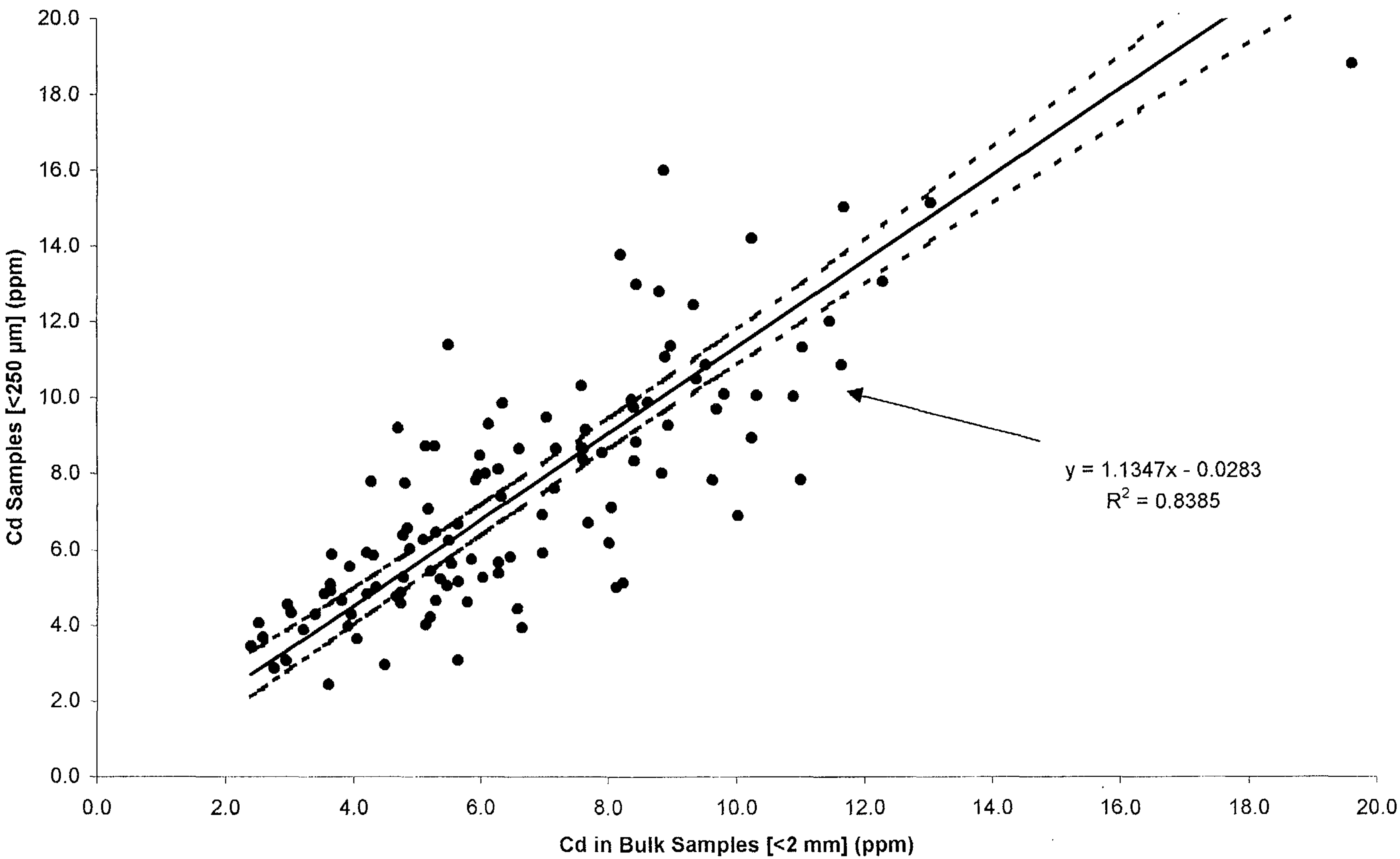

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Figure 3.1-1d - Comparison of Zinc Concentrations in 1998 Bulk Samples and Fines

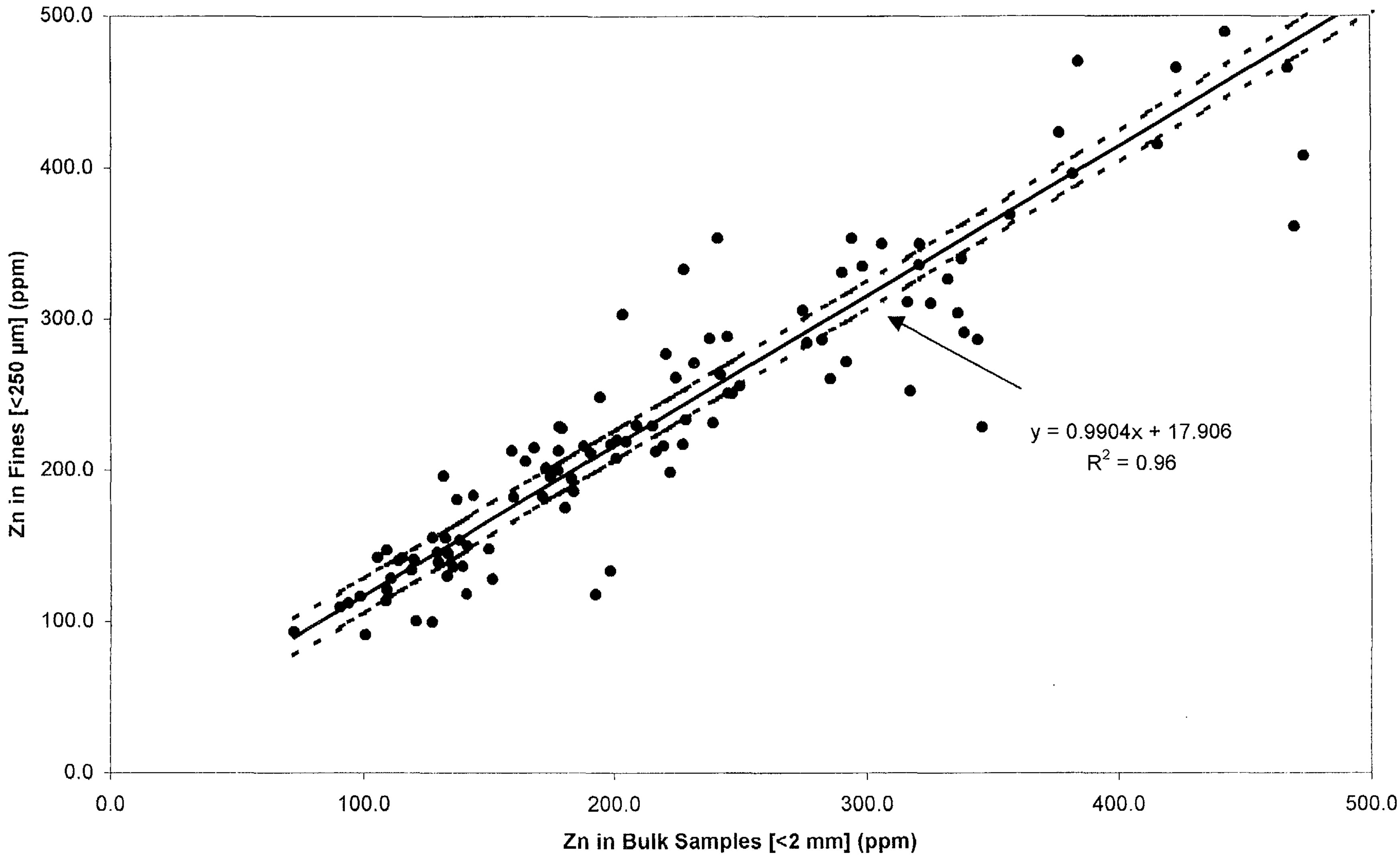

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FIGURE 3.1-2a CHEMICAL FORMS OF ARSENIC IN SITE SOILS

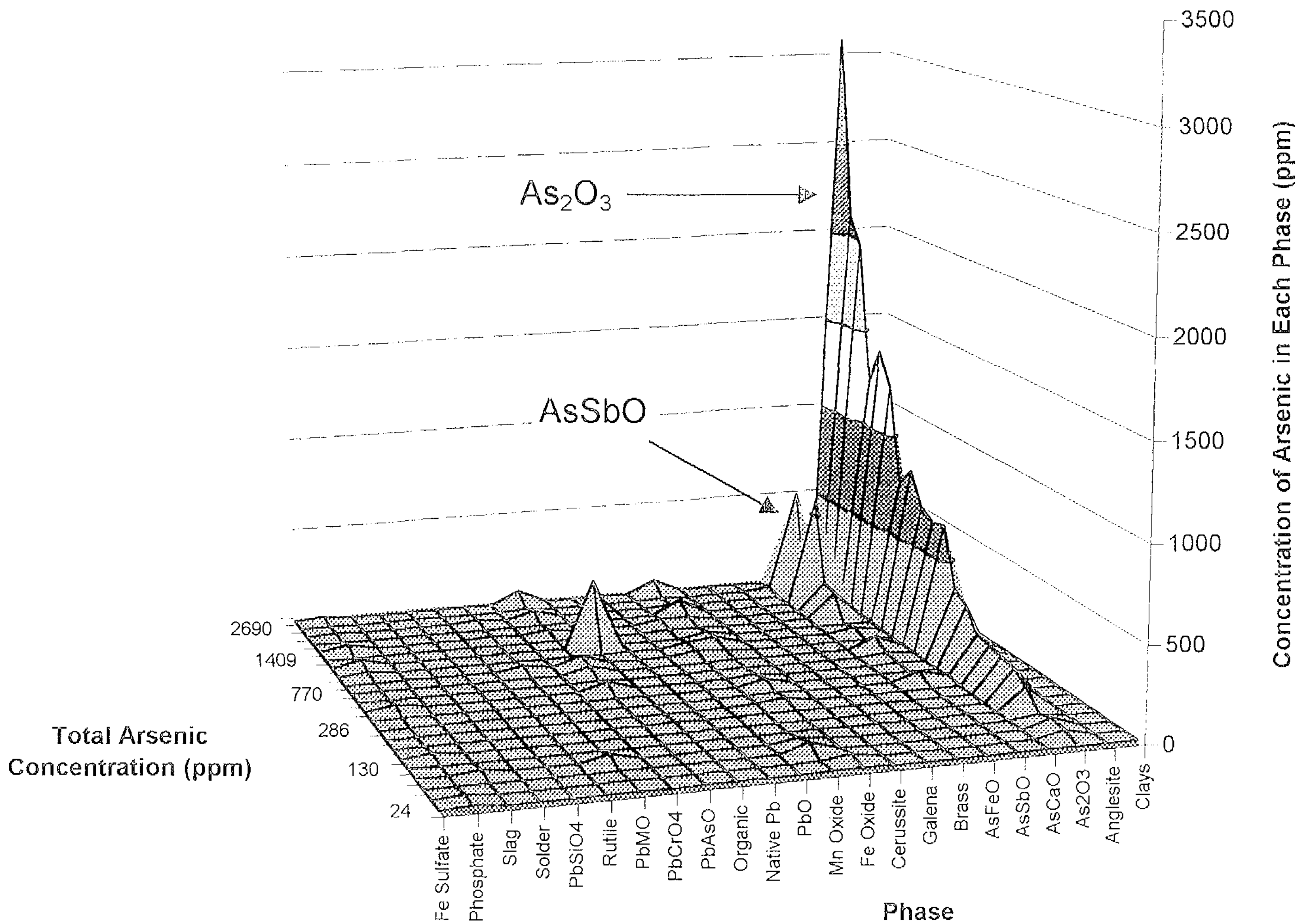

FIGURE 3.1-2b CHEMICAL FORMS OF LEAD IN SITE SOILS

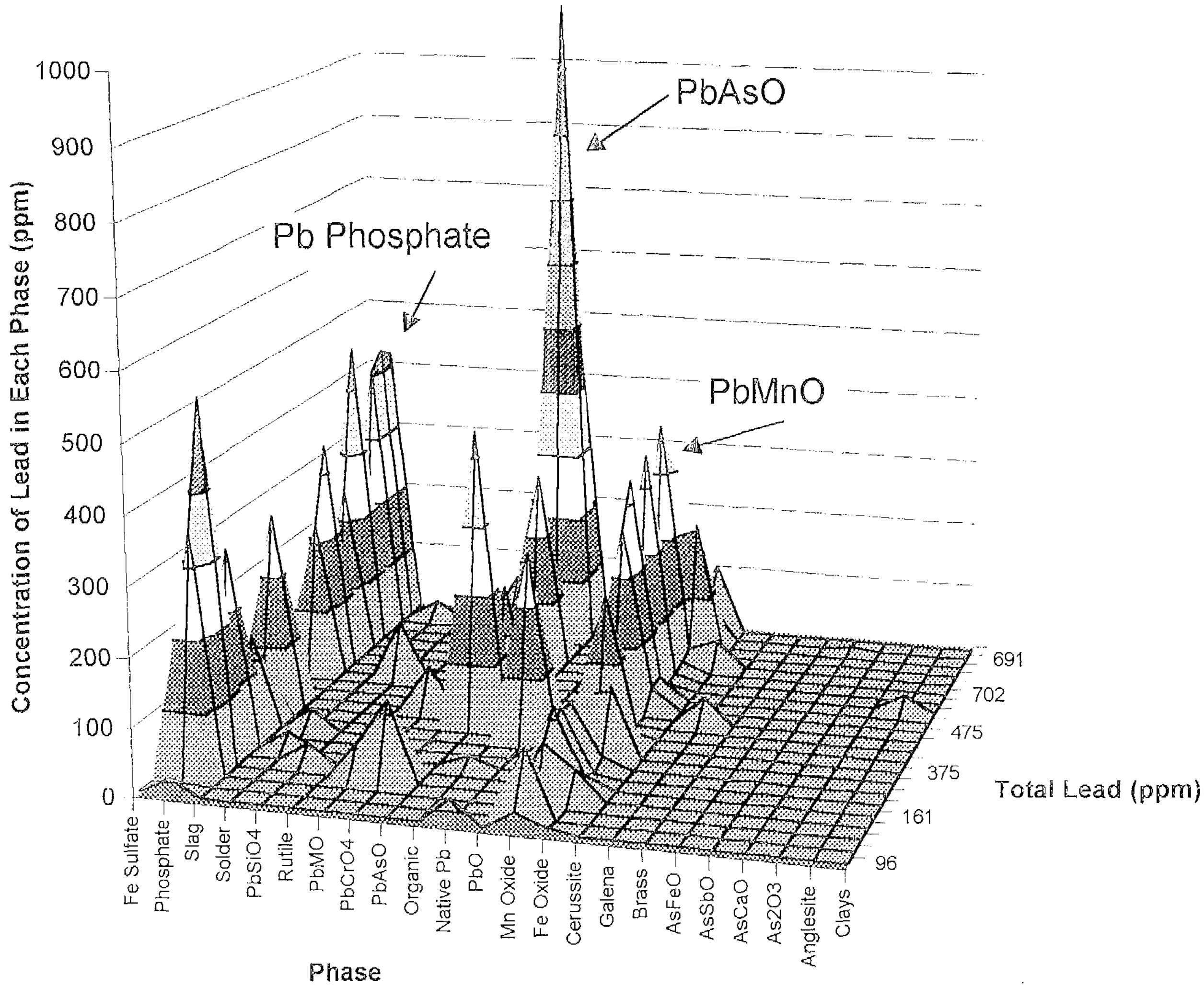

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Figure 3.1-3a: Distribution of Arsenic Mass by Particle Size

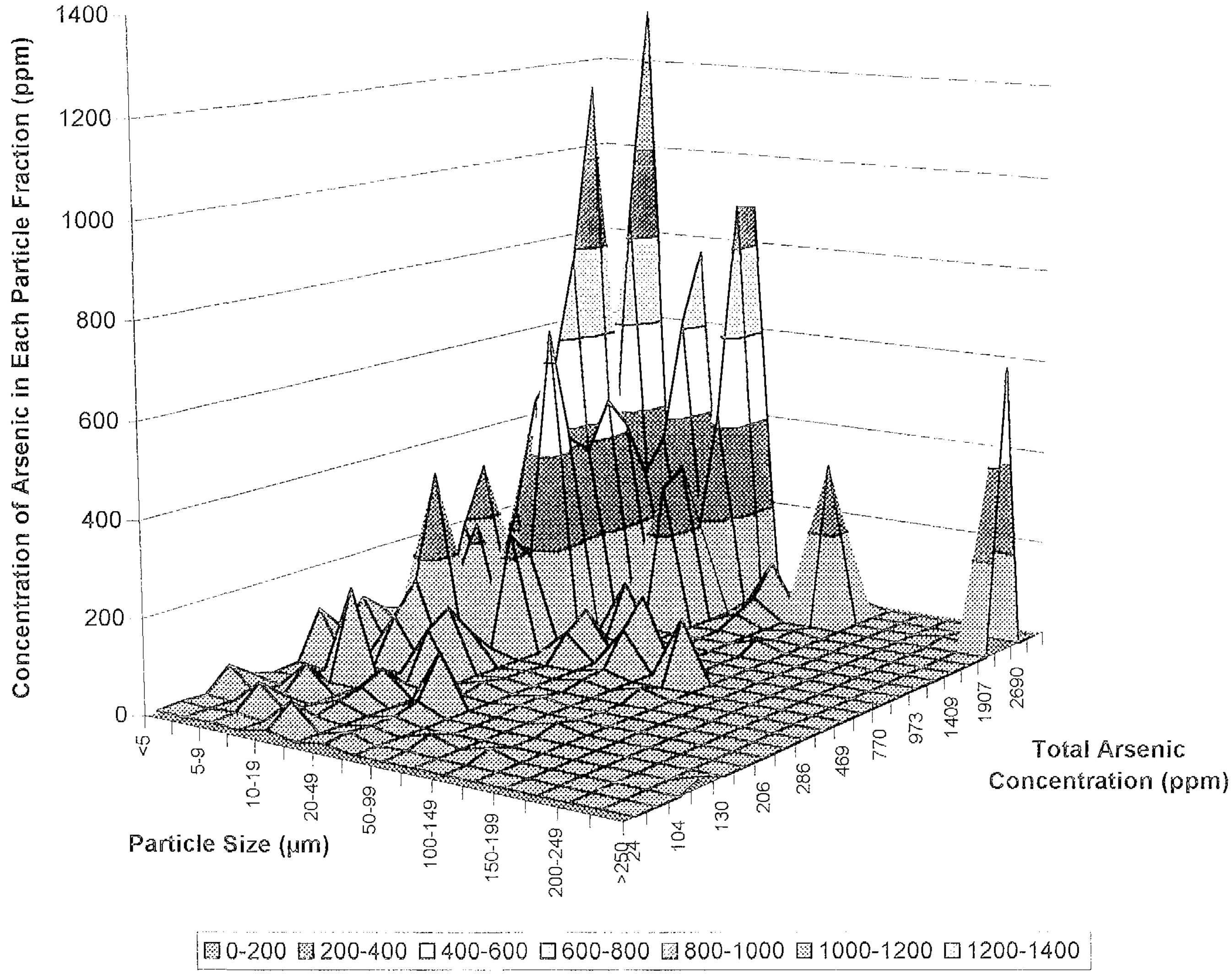

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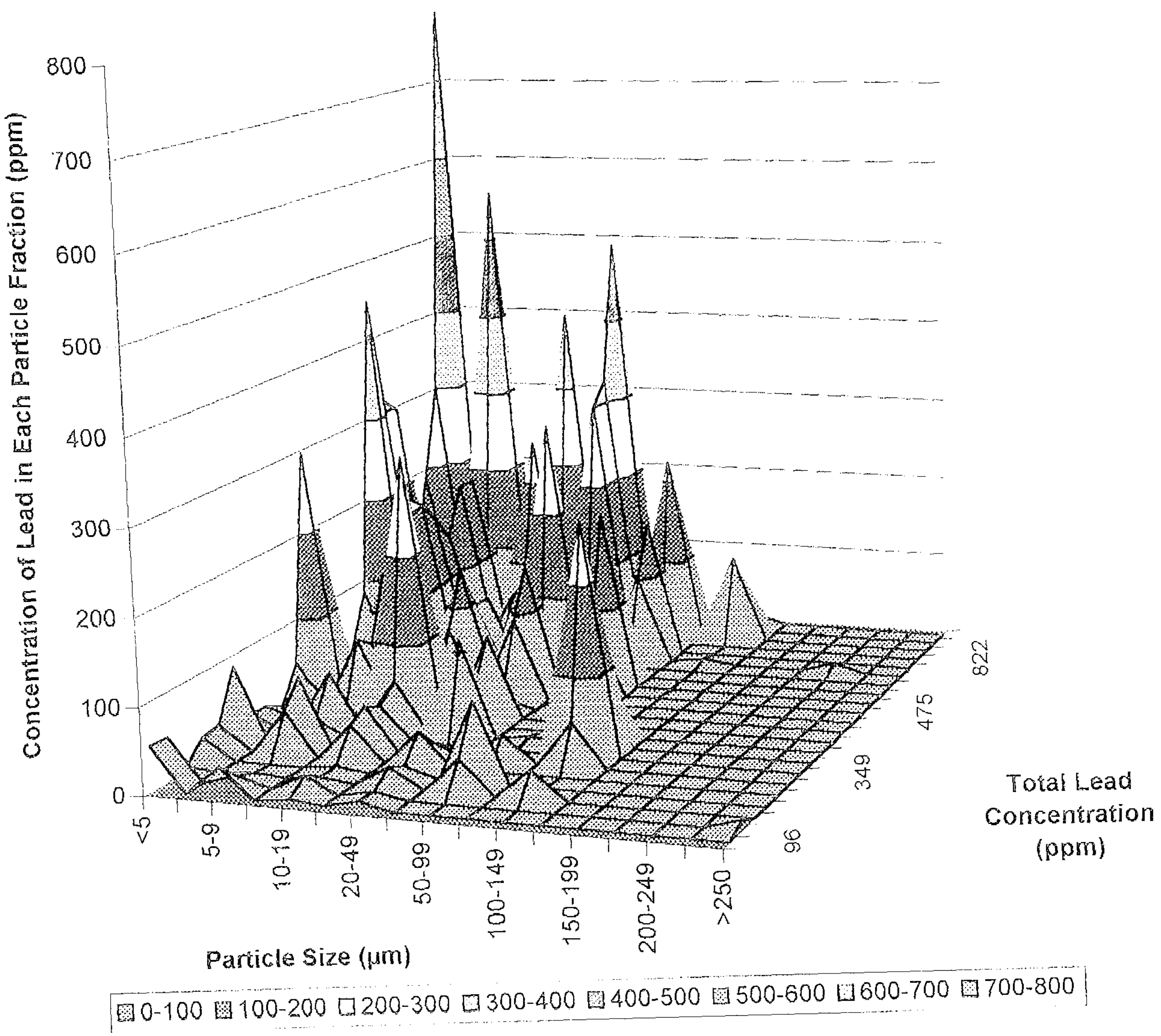
Figure 3.1-3b: Distribution of Lead Mass by Particle Size



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TARGET SHEET

EPA REGION VIII

SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOCUMENT NUMBER: 489928

SITE NAME: Vasquez Blvd & I-70

DOCUMENT DATE: 1-Jul-01

DOCUMENT NOT SCANNED

Due to one of the following reasons:

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- ☐ 3-DIMENSIONAL
- ✓ OVERSIZED
- ☐ AUDIO/VISUAL
- ☐ PERMANENTLY BOUND DOCUMENTS
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DOCUMENT DESCRIPTION:

Phase III Residential Soil Sampling Program Map, Dated June 25, 2001

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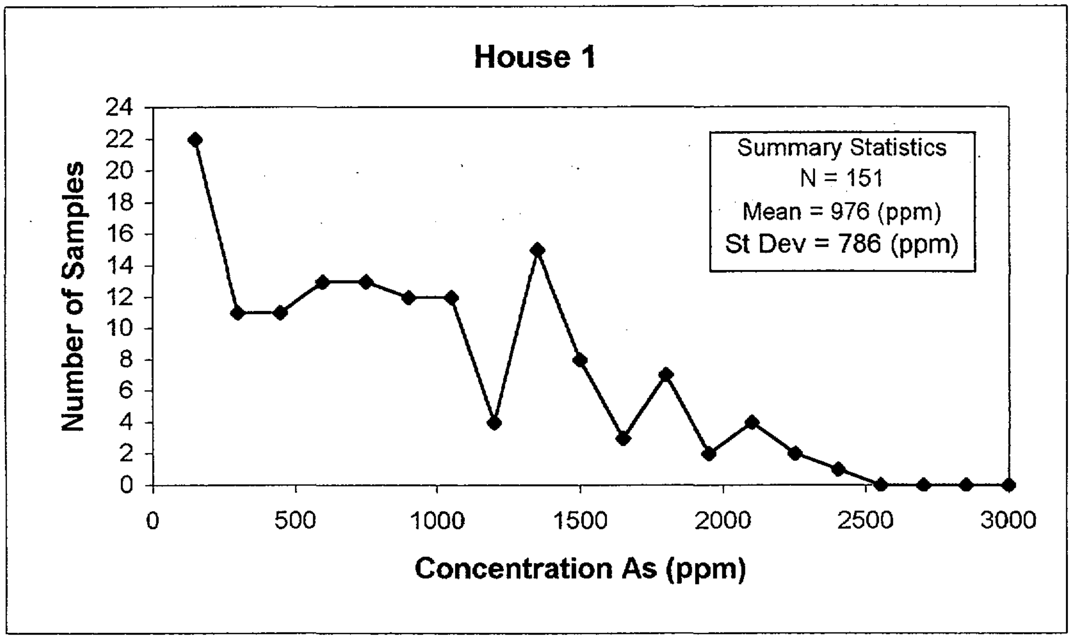
Figure 3.3-1a: Distribution of Arsenic Values at Impacted Properties



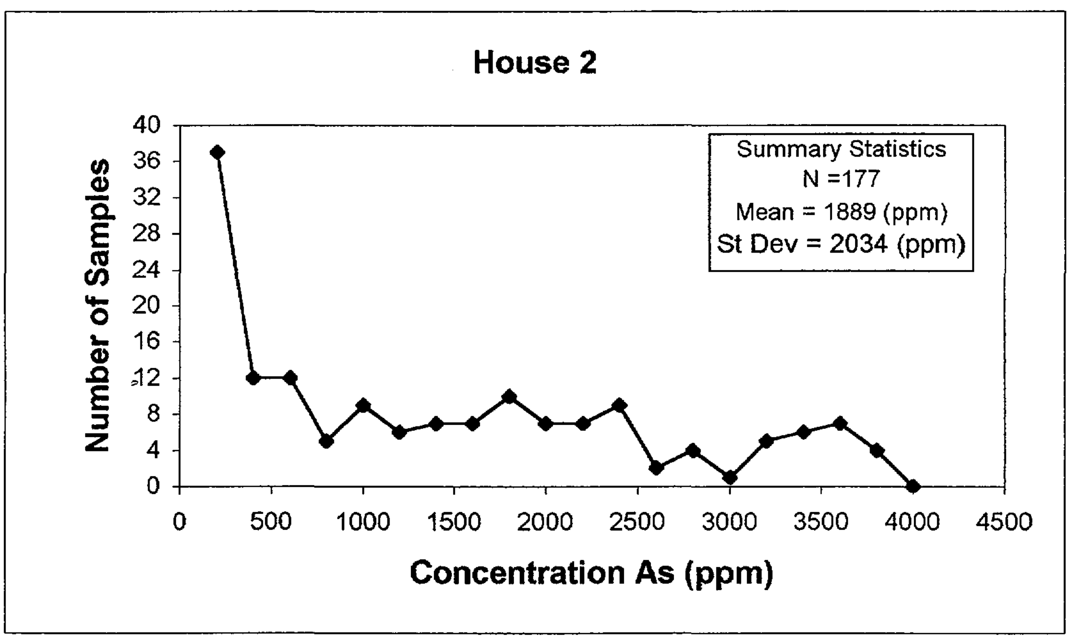


Figure 3.3-1b: Probability Plots of Arsenic Distribution at Impacted Properties

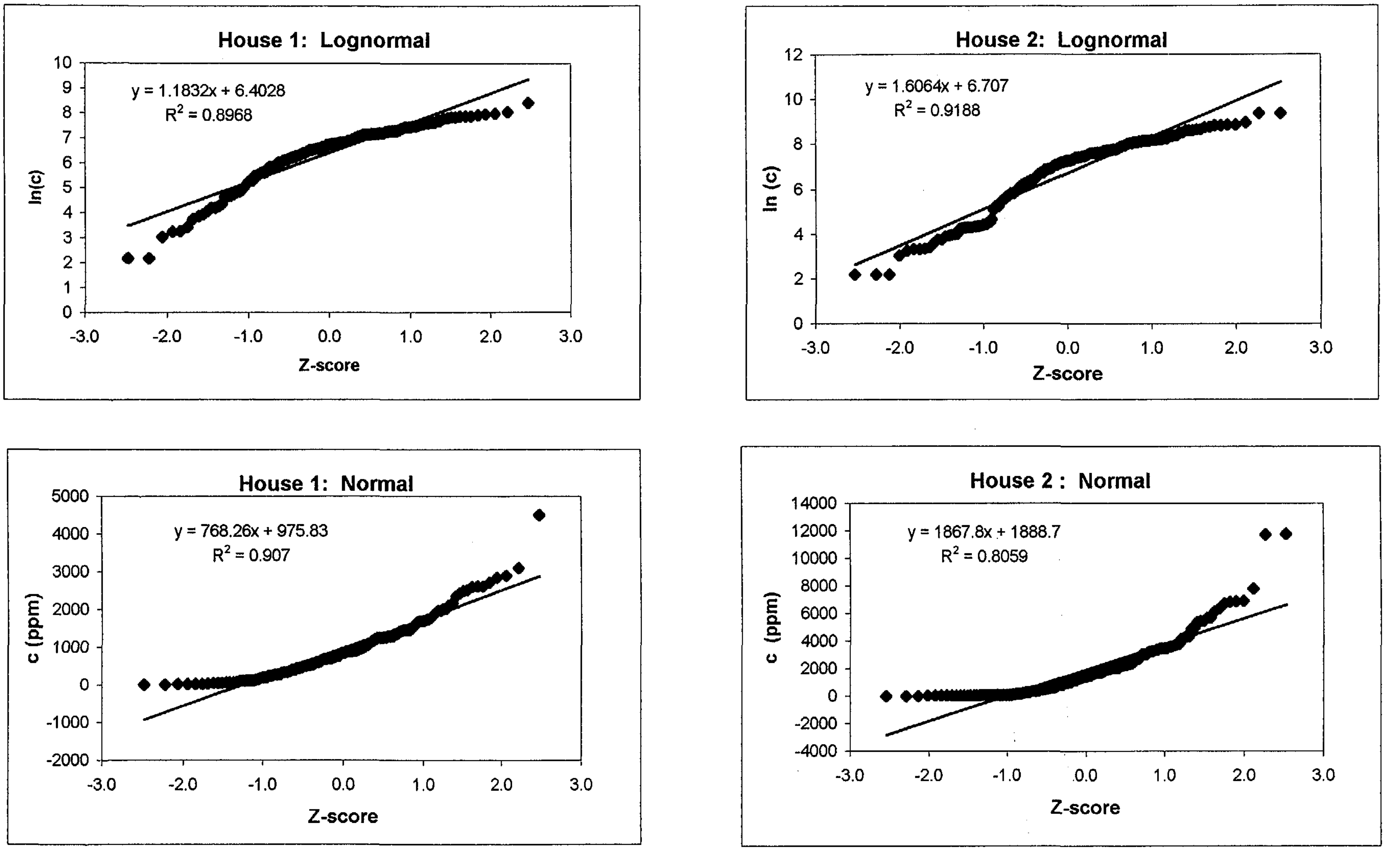


Figure 3.3-1c: Probability Plots of Arsenic Distribution for Minimally Impacted Properties

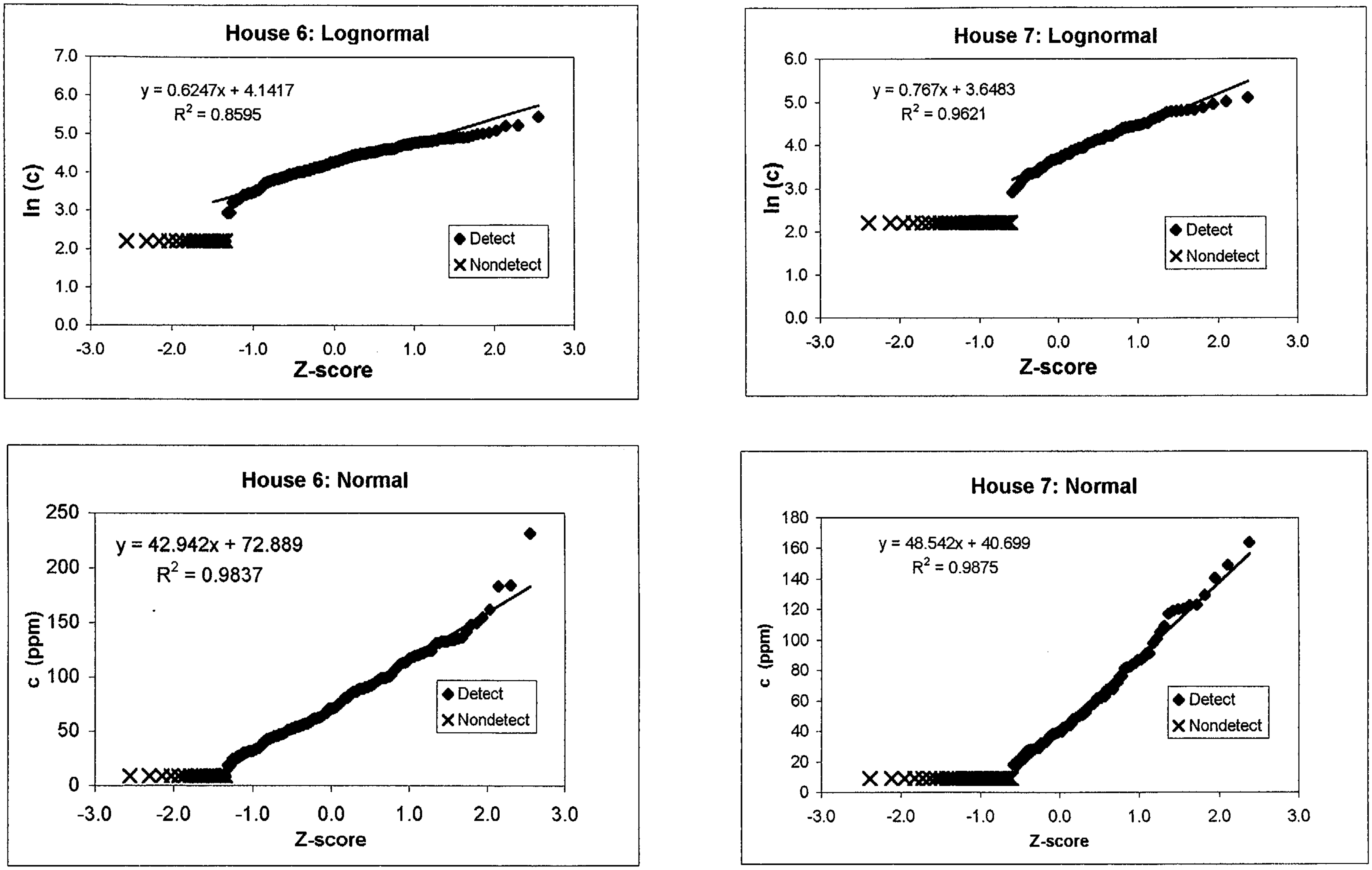
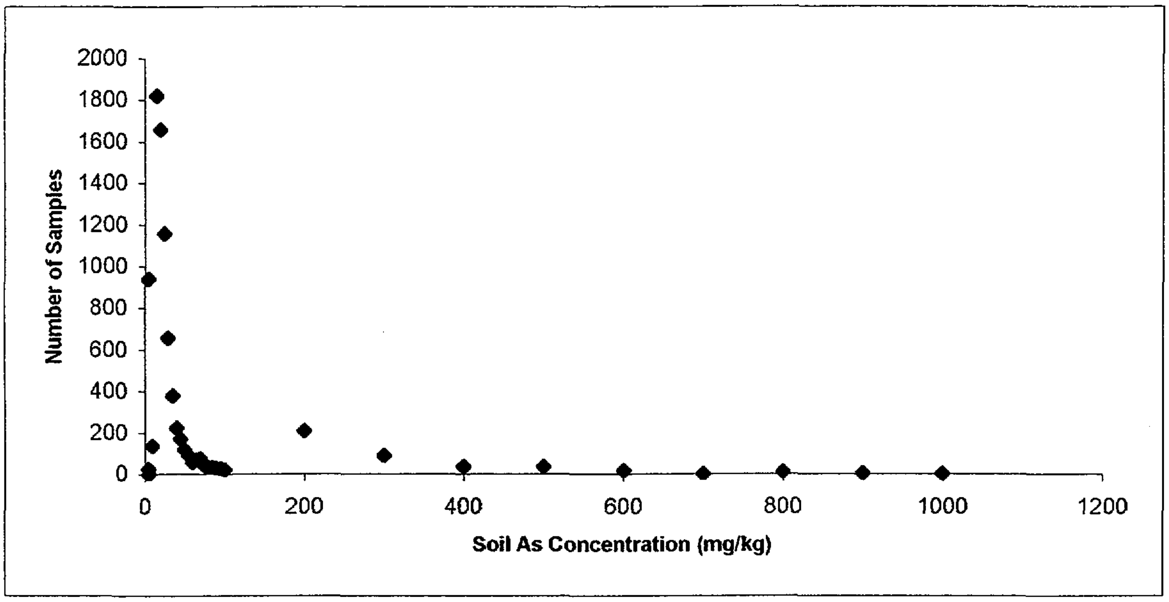
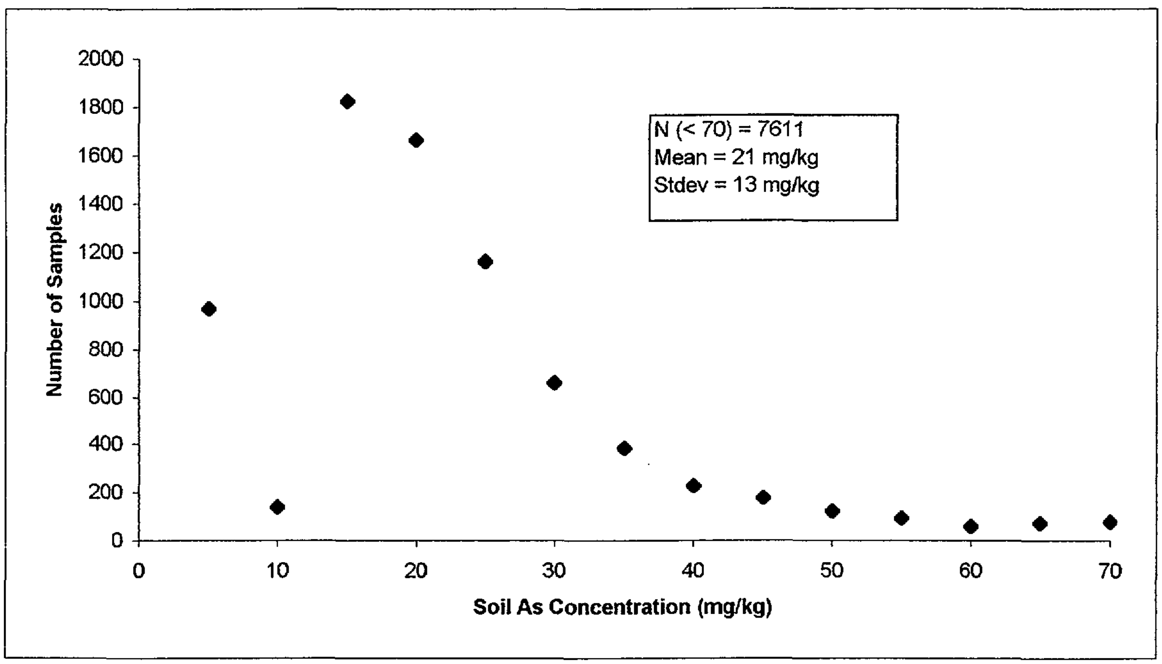


Figure 3.3-1d. Arsenic Levels in Surface Soil at Unimpacted Residences in the Globeville Area





Note: All samples below the detection limit (10 ppm) were assigned a value of 5 mg/kg

Data Source: ASARCO

Figure 3.3-2a
Distribution of Property Arsenic Concentrations (Mean)

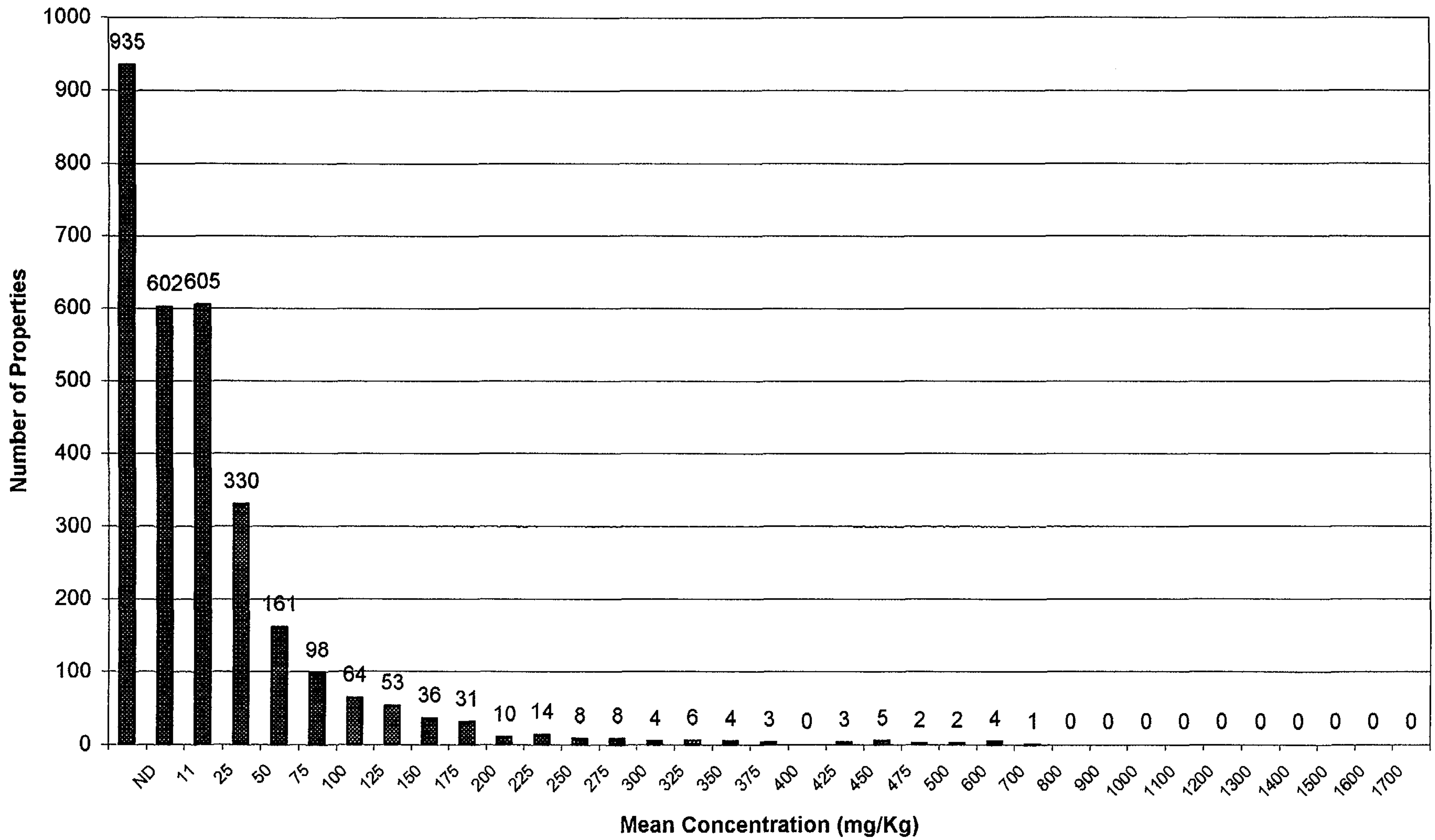


FIG3.3-2a ASMeanHisto2989Prop.xls

Figure 3.3-2b
Distribution of Property Arsenic Concentrations (95% Upper Confidence Limit of the Mean)

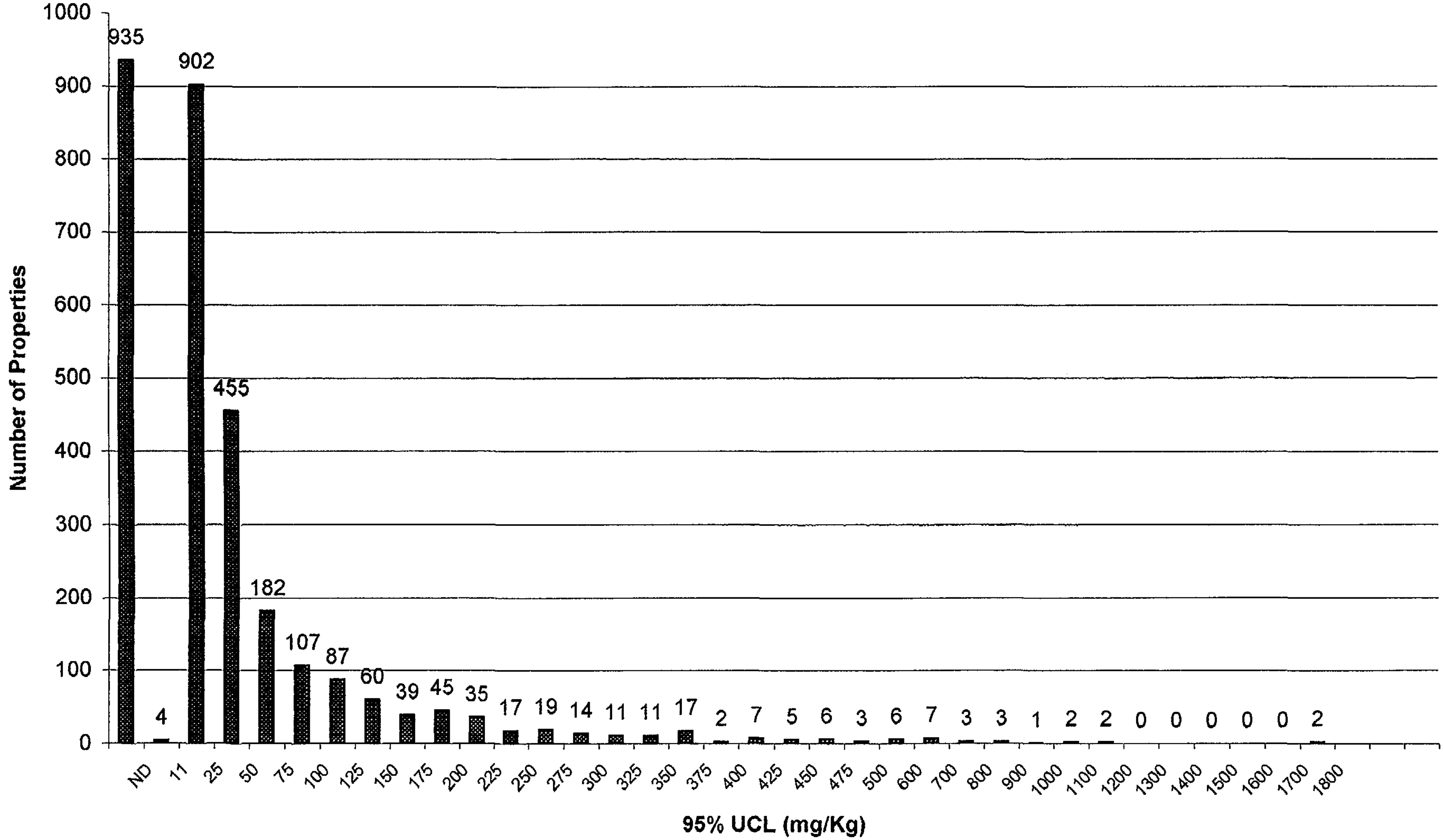


FIG3.3-2b AS_95%UCL2989Prop.xls

Figure 3.3-2c
Distribution of Property Lead Concentration (Mean)

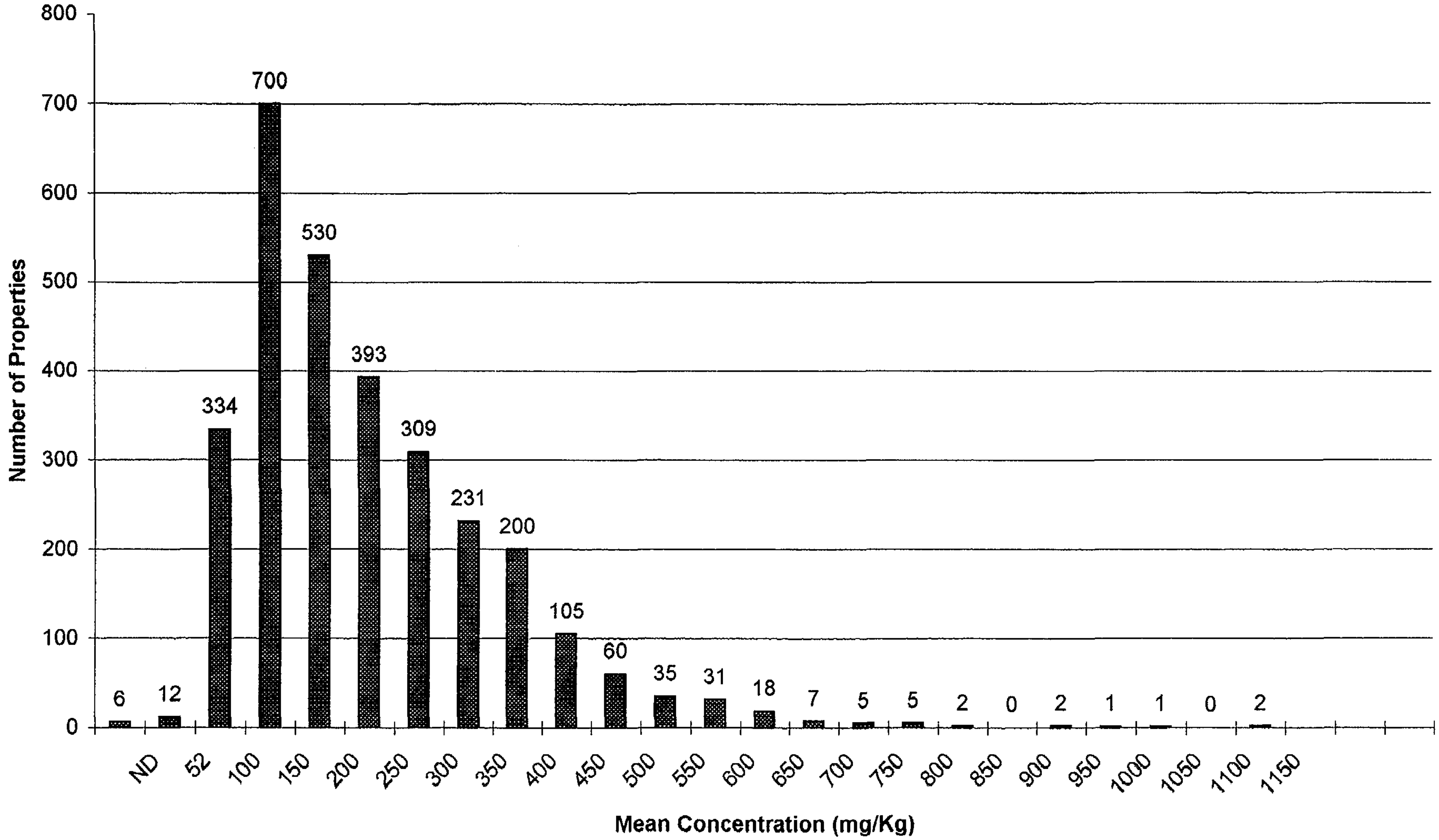


FIG3.3-2c PB_MEAN-CONC2989Prop.xls

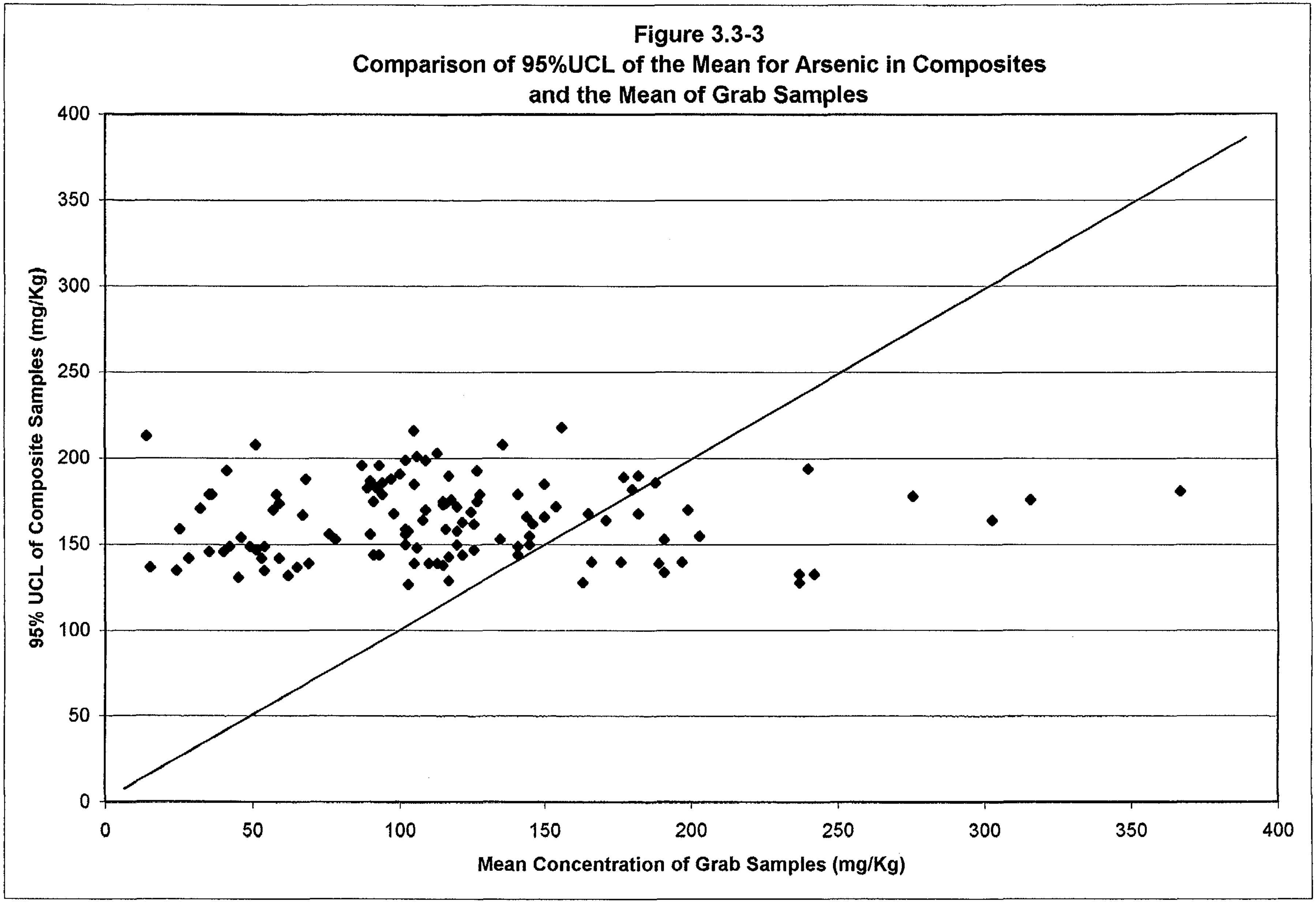
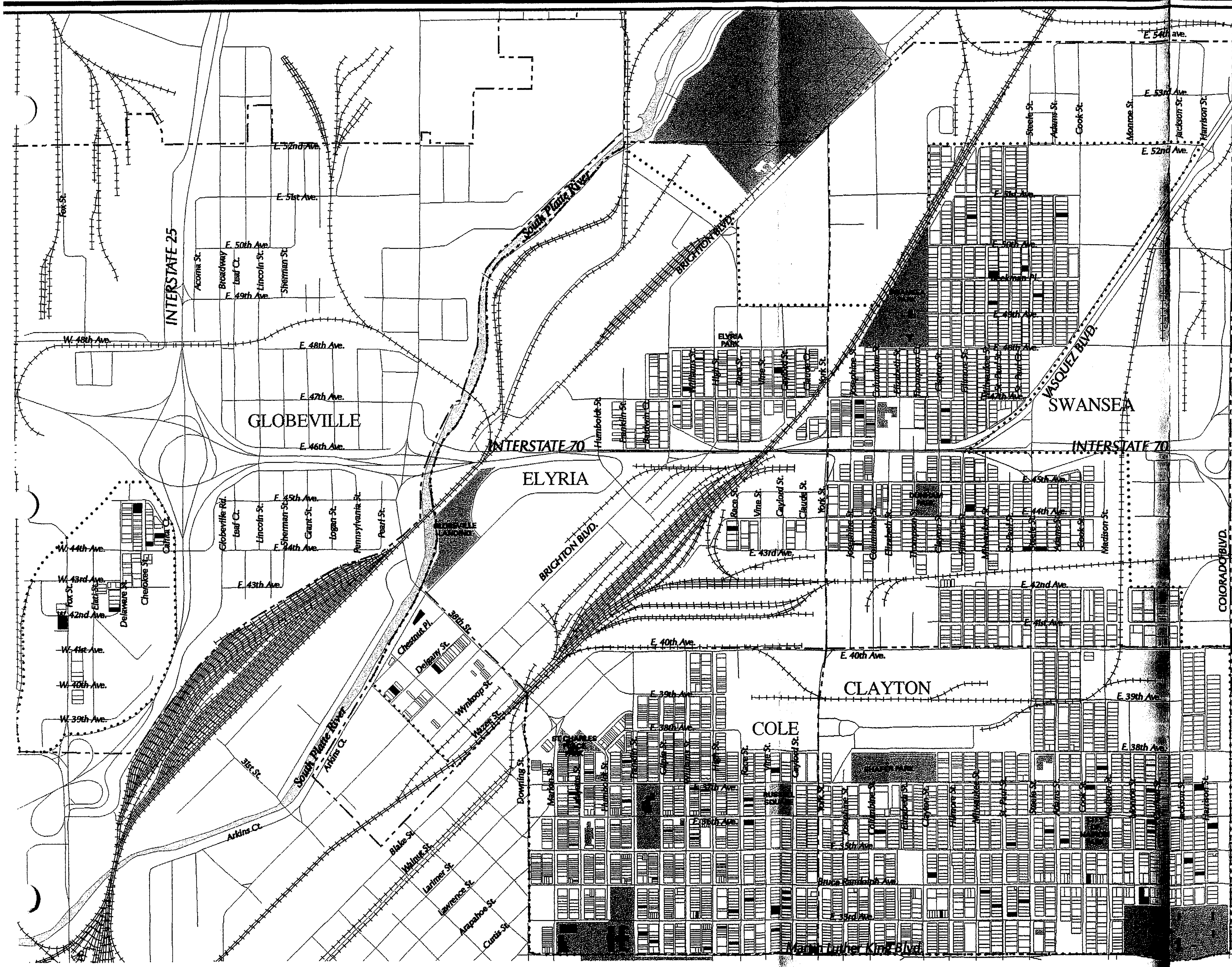


Figure 3.3-3
Comparison of 95%UCL of the Mean for Arsenic in Composites
and the Mean of Grab Samples
95% UCL of Composite Samples (mg/Kg)
Mean Concentration of Grab Samples (mg/Kg)
0
50
100
150
200
250
300
350
400



N

0 250 500 1000 1500 2000 FEET

0.1 .05 0 0.1 MILE

0.5 .25 0 KM

Transverse Mercator Projection

UTM Coordinate System – Zone 13

NAD27/NGVD29 Datum – Units Meters

LEGEND

- Study Area Boundary
- Neighborhood Boundary
- Household Dust Samples Collected
- Vegetable and Garden Soil Samples Collected
- Household Dust, Vegetable and Garden Soil Samples Collected

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VASQUEZ BLVD / I-70 SITE
Operable Unit 1
Remedial Investigation Report

Figure 3.3-4

Household Dust, Garden Vegetable, and Garden Soil Sampling Locations

Project No.: RAC 68-W7-0039 WA 004-RICO-089R
File: Q:\4994\1004\RIFS\dvs11x27.eps
June 27, 2001

Figure 3.3-5a
Comparison of Arsenic Concentrations in Indoor Dust and Yard Soils

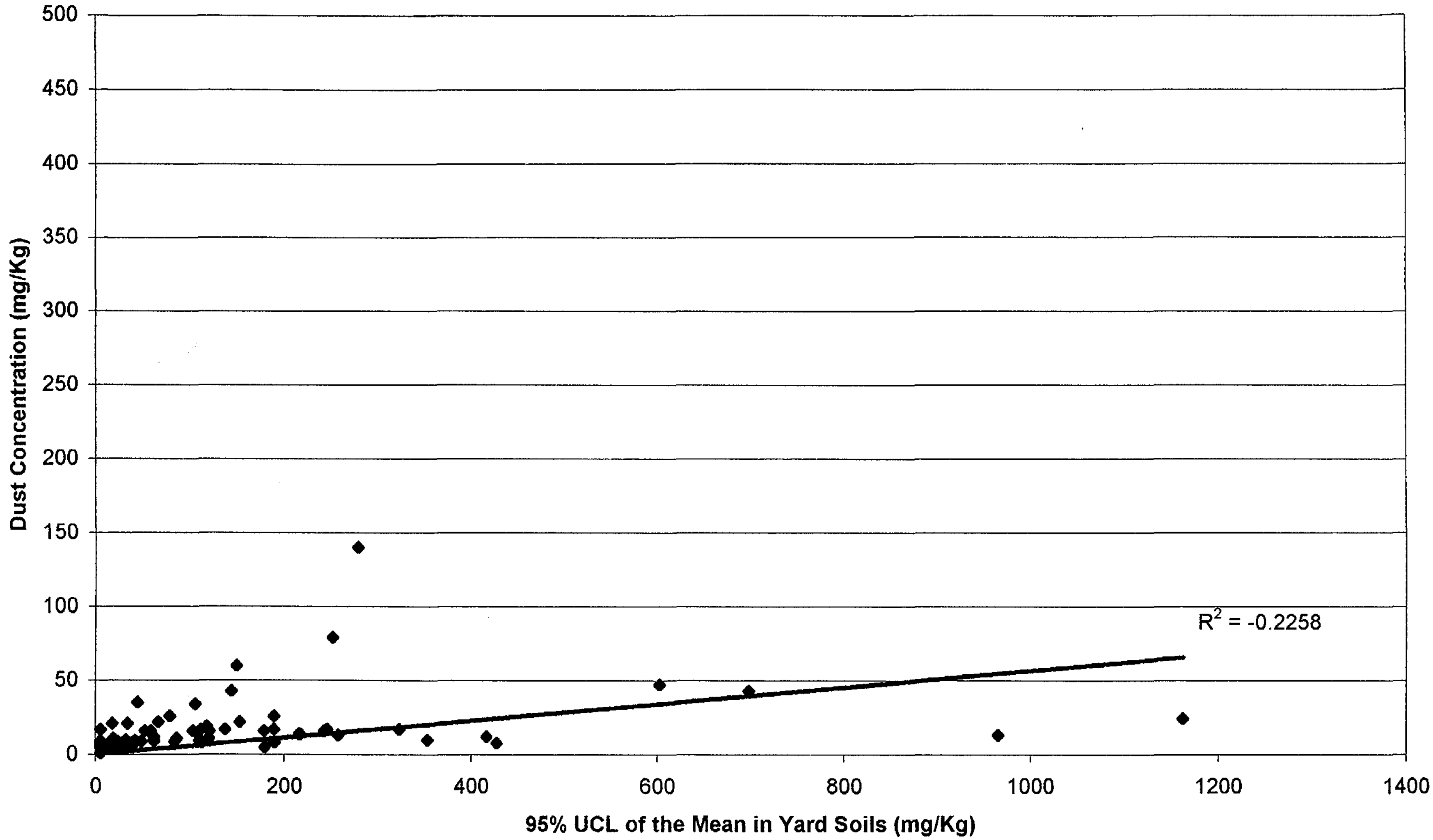


FIG3.3-5a AsDustVsSoil.xls

Figure 3.3-5b
Comparison of Lead Concentrations in Indoor Dust and Yard Soils

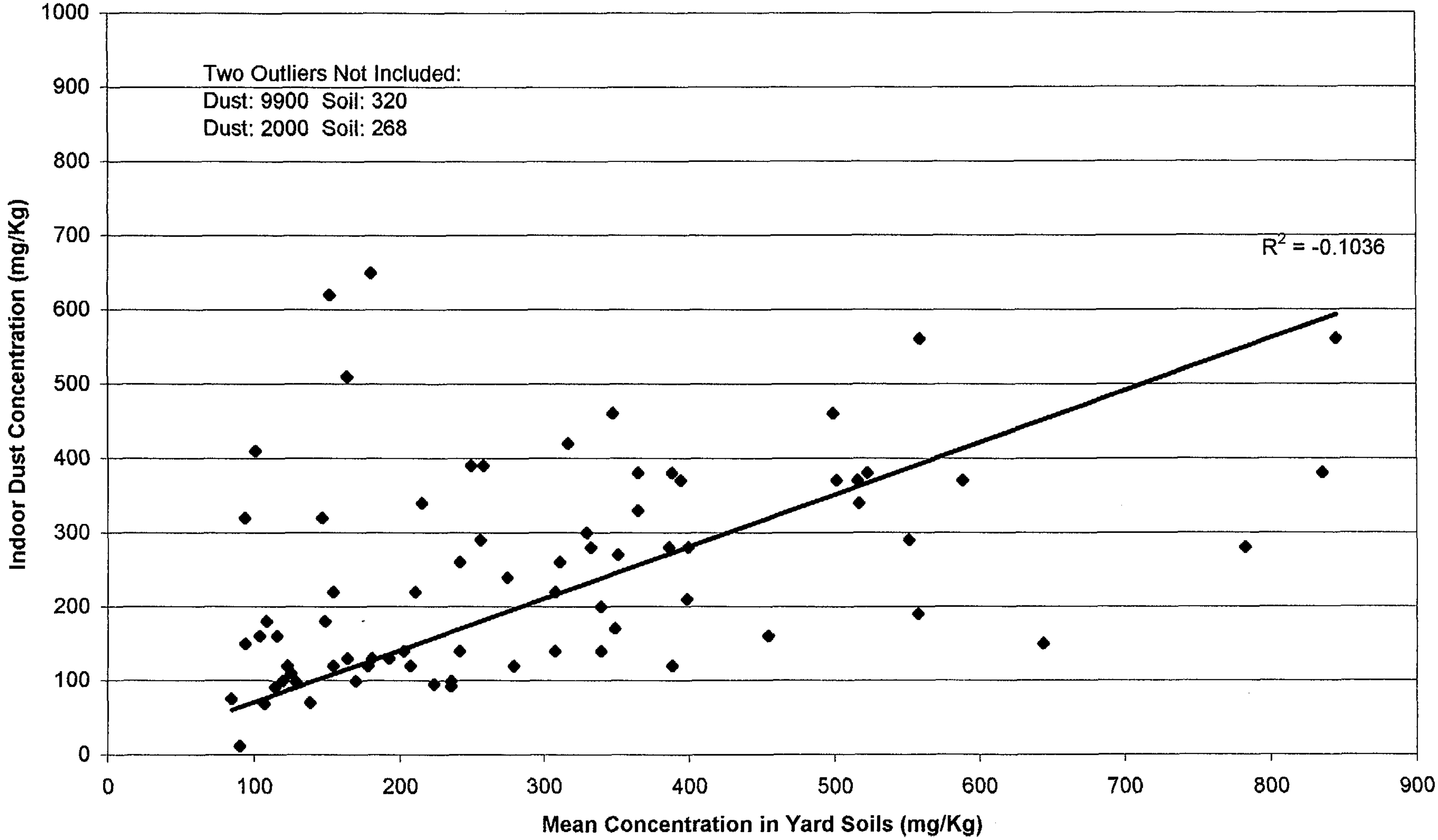


FIG3.3-5b PbDustVsSoil.xls

Figure 3.3-6a
Comparison of Arsenic Concentrations
in Garden Vegetables and Garden Soils

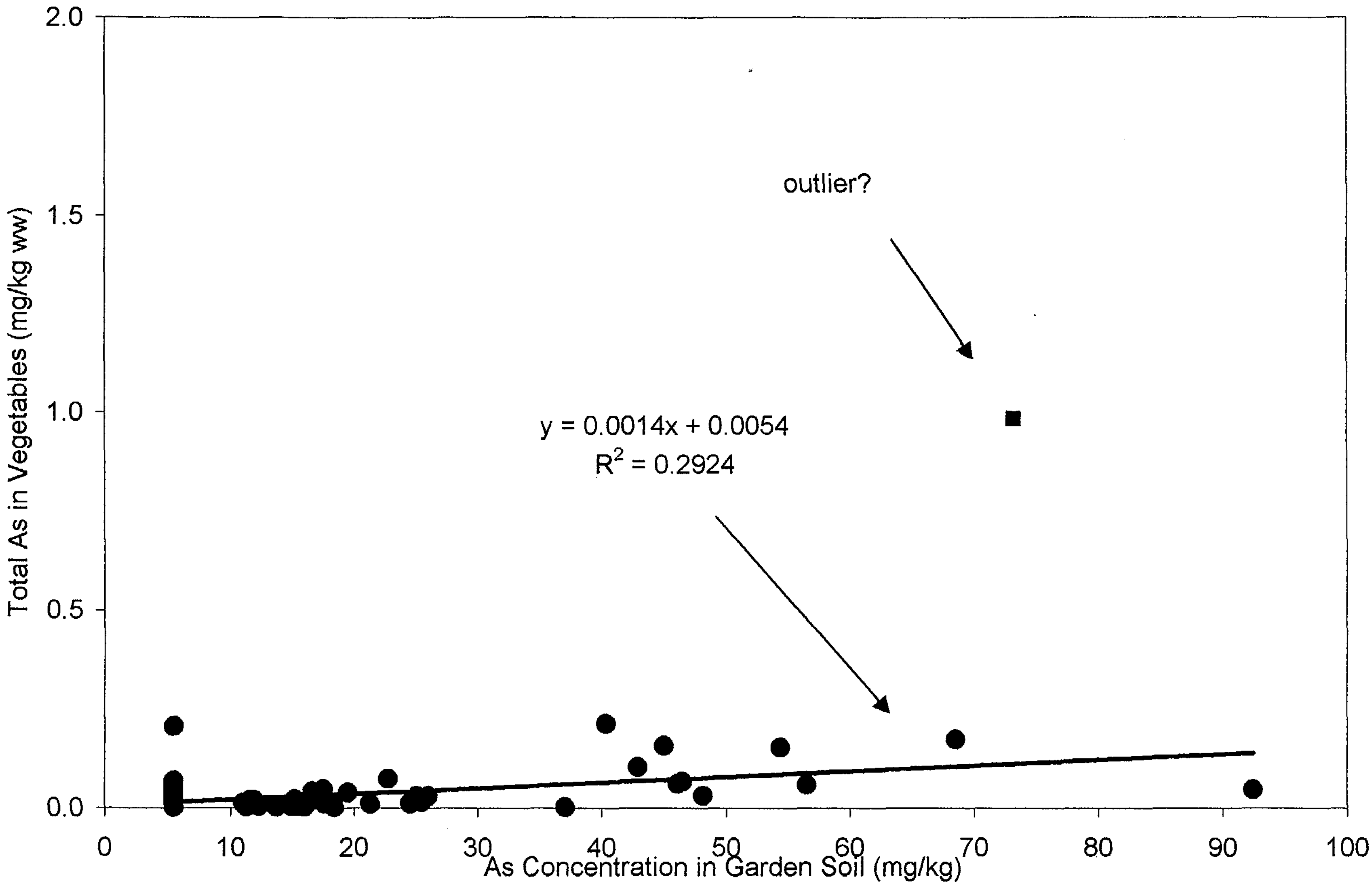


fig.3-3-6a.xls

fig.3.3-6a

Figure 3.3-6b
Comparison of Lead Concentrations in Garden Vegetables and Garden Soil

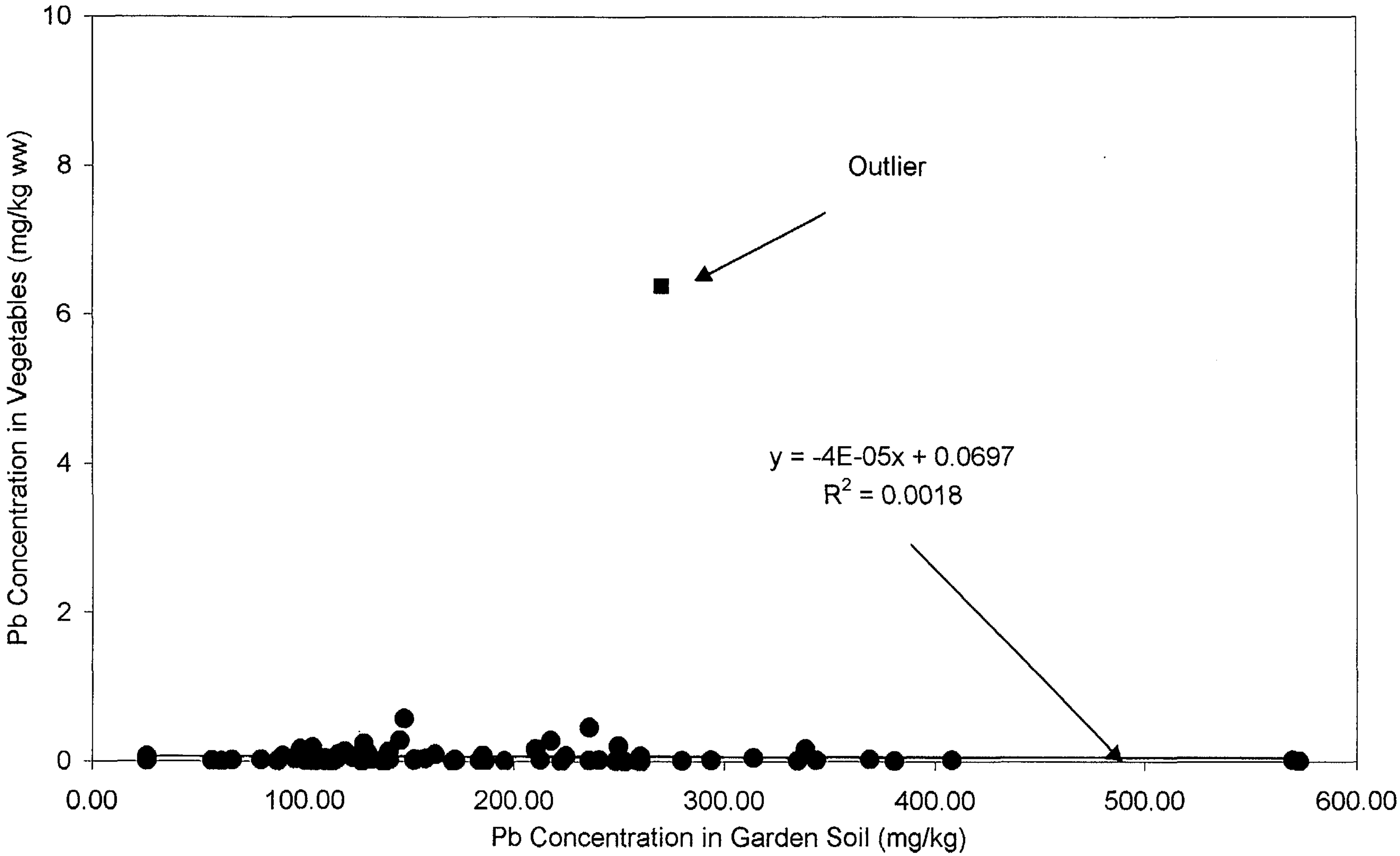
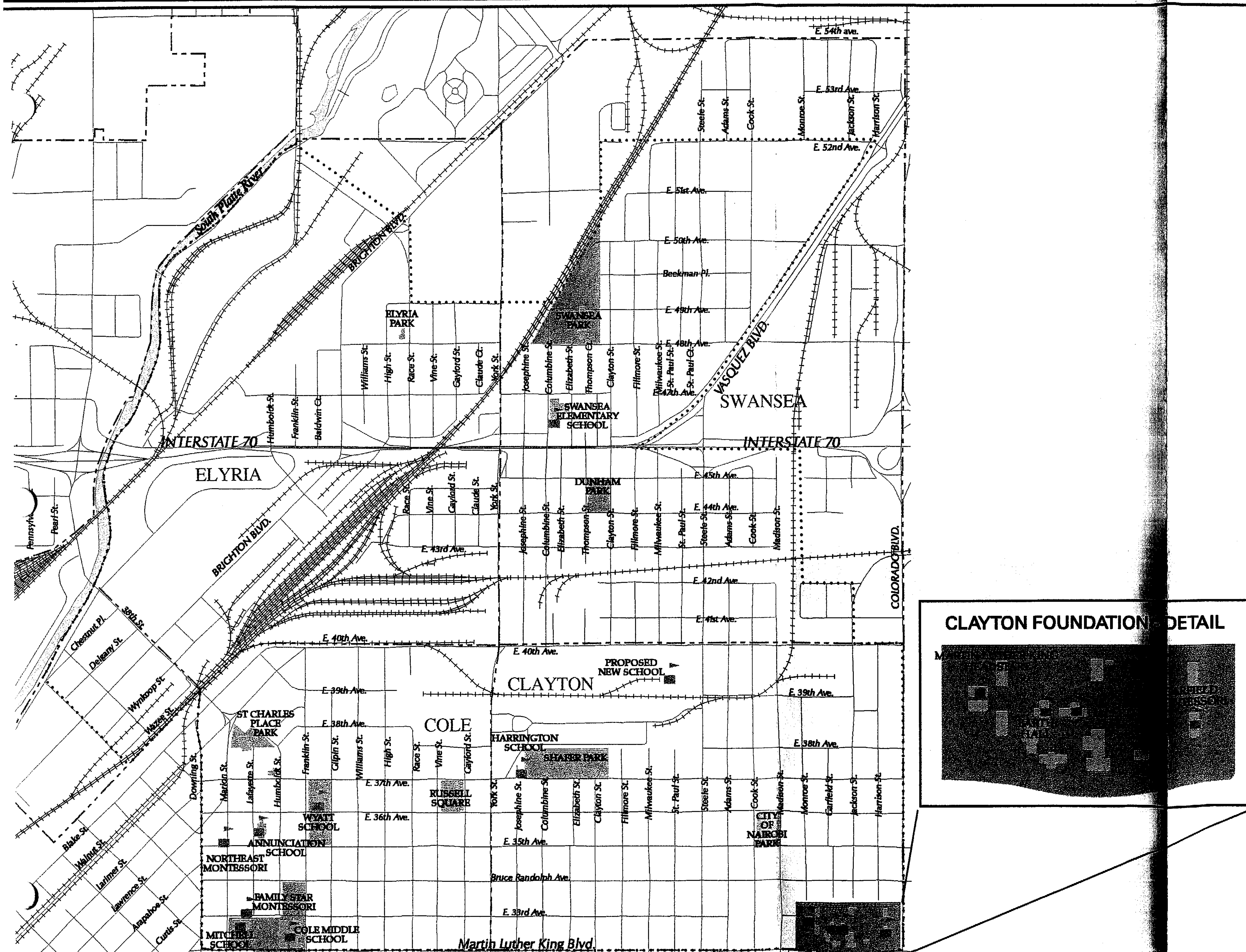


fig.3-3-6a.xls



N

0 250 500 1000 1500 2000 FEET

0.1 .05 0 0.1 MILE

0.5 .25 0 KM

Transverse Mercator Projection

UTM Coordinate System – Zone 13

NAD27/NGVD29 Datum – Units Meters

LEGEND

- ..... Study Area Boundary
- — - Neighborhood Boundary

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

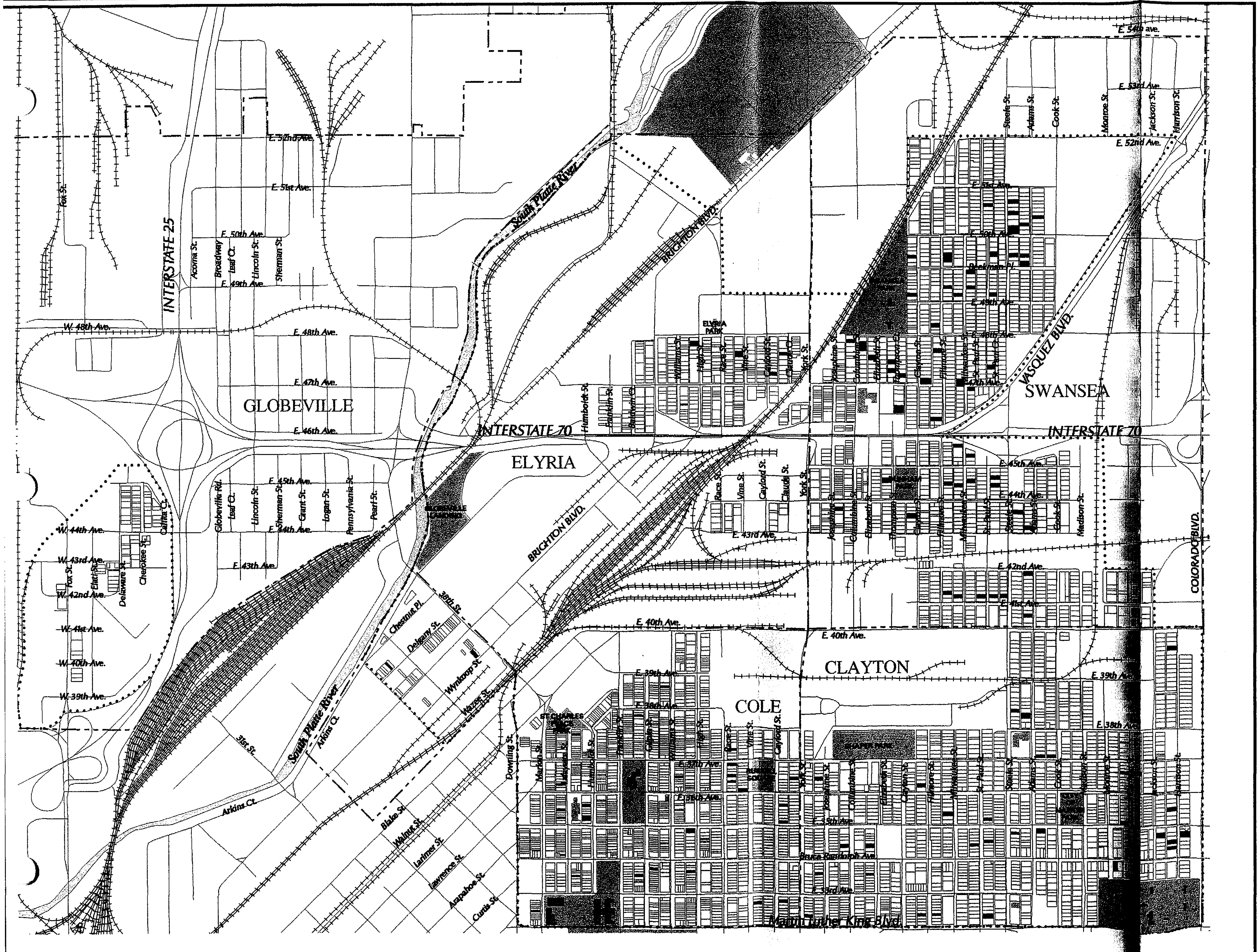
VASQUEZ BLVD / I-70 SITE
Operable Unit 1
Remedial Investigation Report

Figure 3.3-7

School and Park Sampling

Project No.: RAC 68-W7-0039 WA 004-RICO-089R
File: Q:\4994\1004\RIFS\scpk11x27.eps

June 27, 2001



N

0 250 500 1000 1500 2000 FEET

0.1 .05 0 0.1 MILE

0.5 .25 0 KM

Transverse Mercator Projection

UTM Coordinate System – Zone 13

NAD27/NGVD29 Datum – Units Meters

LEGEND

Study Area Boundary

Neighborhood Boundary

Grab Sample Locations

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

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Operable Unit 1
Remedial Investigation Report

Figure 3.3-8

Residential Grab Soil Sampling Locations

Project No.: RAC 68-W7-0039 WA 004-RICO-089R
File: Q:\4994\1004\RIFS\grabs11x27.eps

June 27, 2001

Figure 3.3-9a
Comparison of Arsenic Concentrations in Phase III Bulk and Fine Fraction Soils

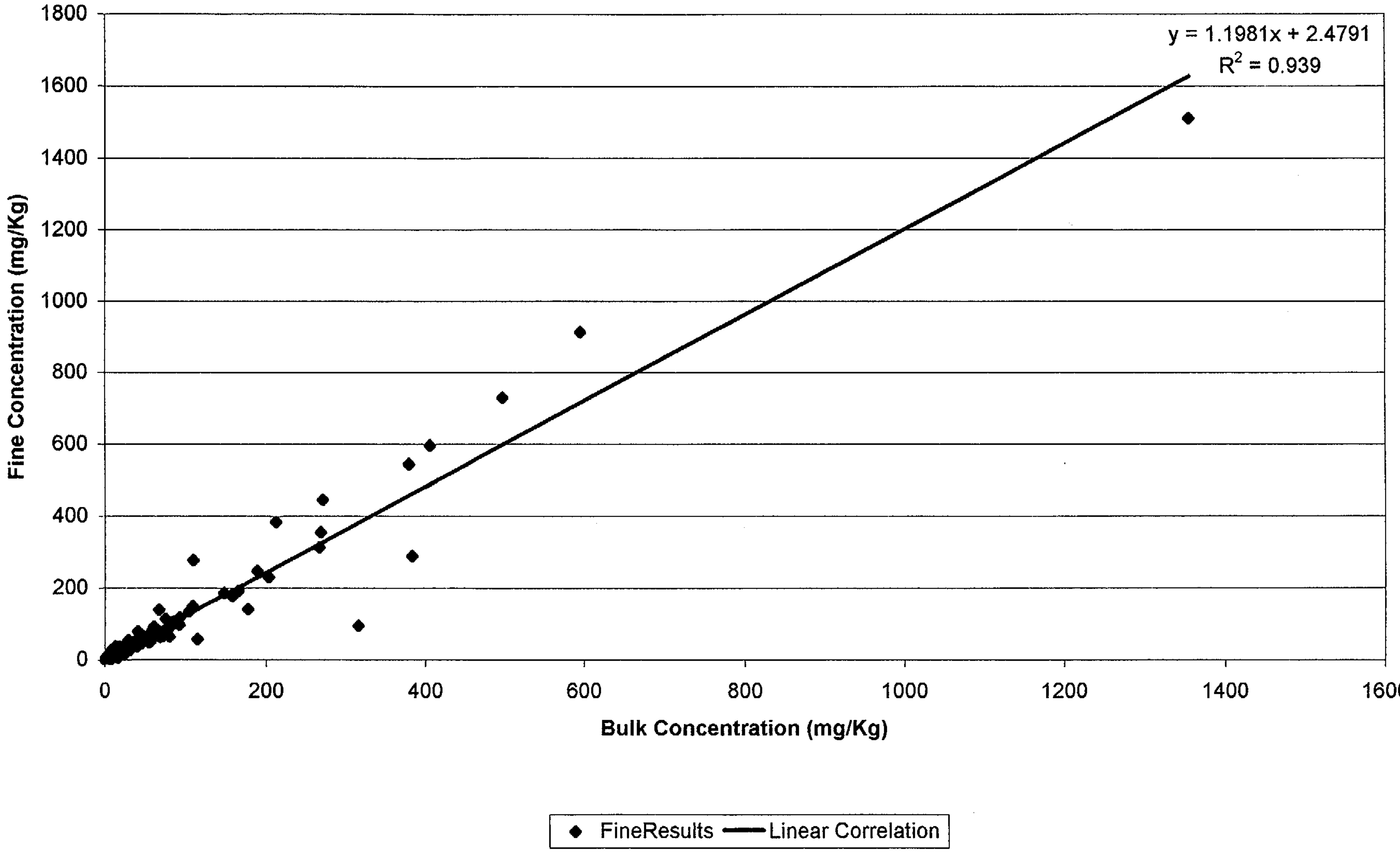


FIG3.3-9a FineVsBulk_As.xls

Figure 3.3-9b
Comparison of Lead Concentrations in Phase III Bulk and Fine Fraction Soils

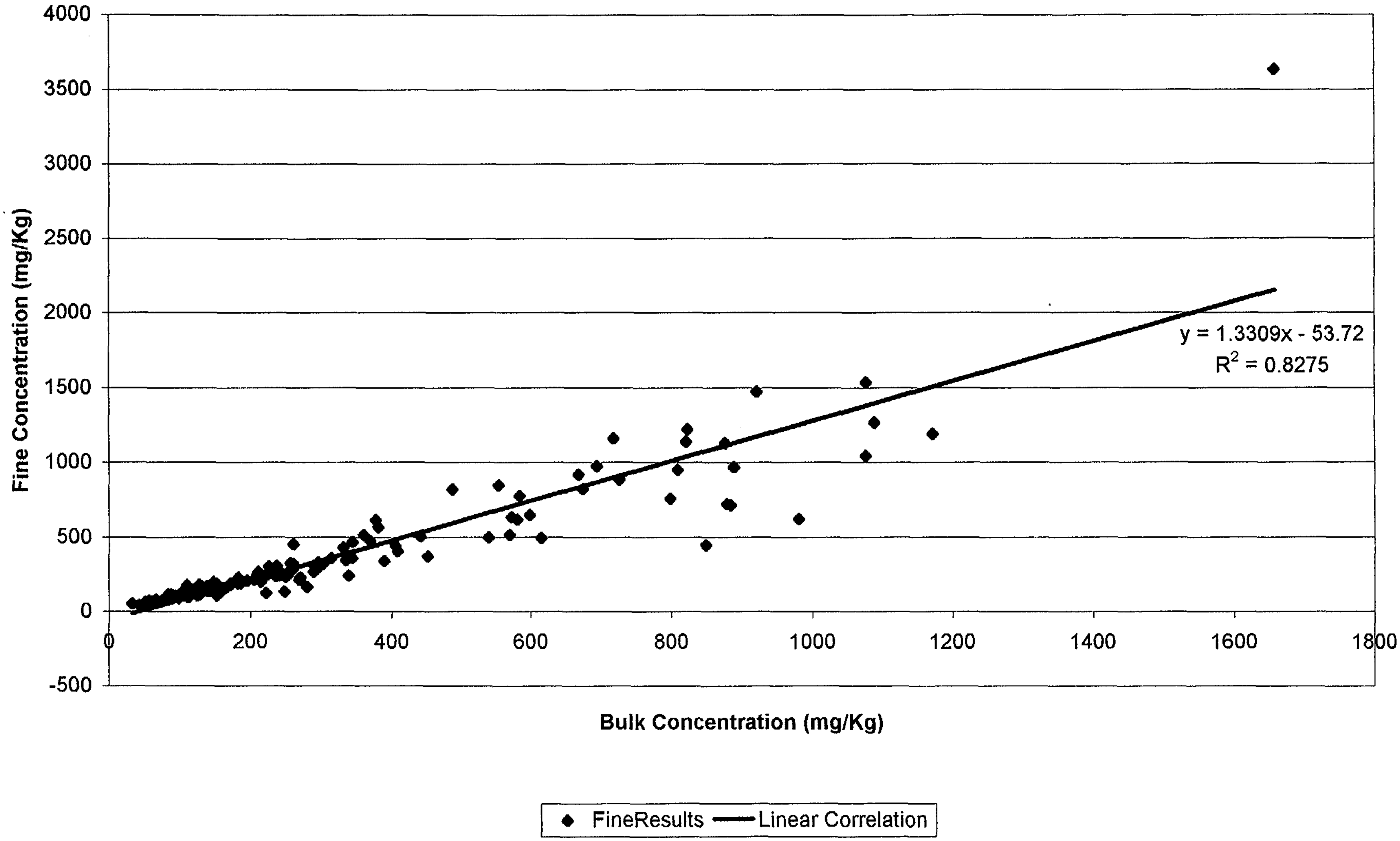


FIG3.3-9b FineVsBulk_Pb.xls

Figure 4-1

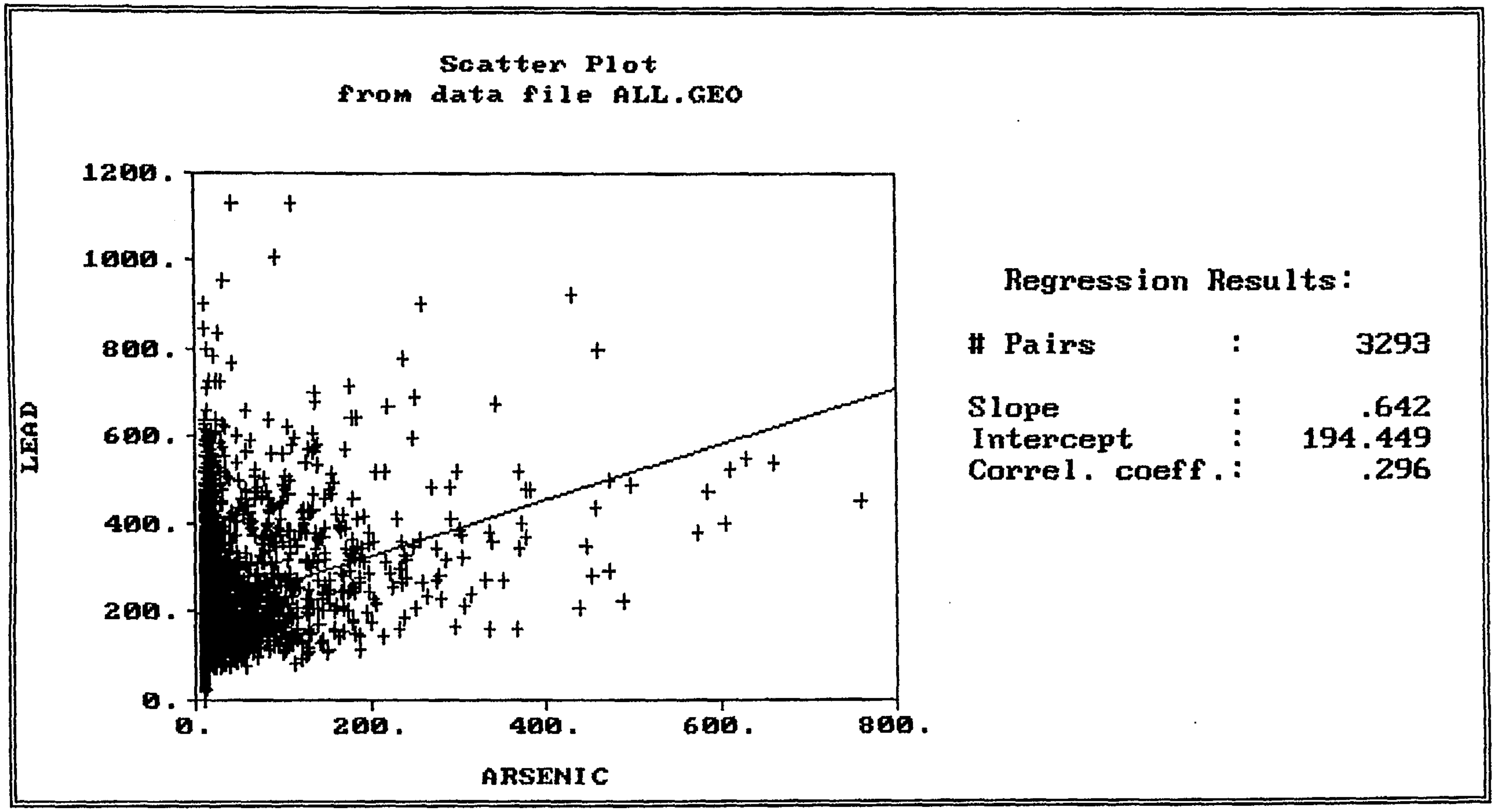

Scatter Plot
from data file ALL.GEO
1200.
1000.
800.
600.
400.
200.
0.
LEAD
0.
200.
400.
600.
800.
ARSENIC
Regression Results:
Pairs : 3293
Slope : .642
Intercept : 194.449
Correl. coeff.: .296

Figure 4-2a
Variogram for Arsenic
Major Axis of Continuity (East - West)

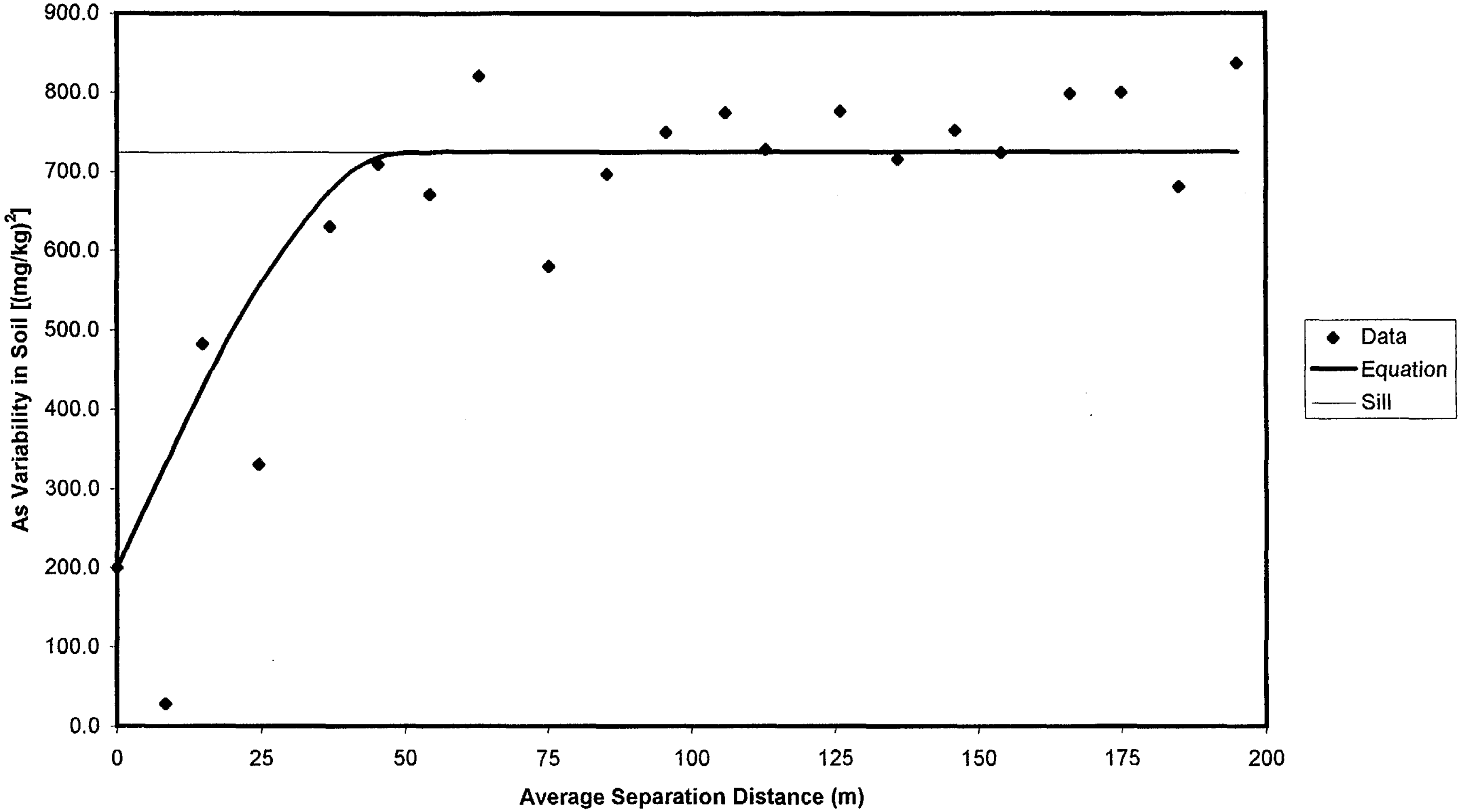


Figure 4-2b
Variogram for Arsenic
Minor Axis of Continuity (North-South)

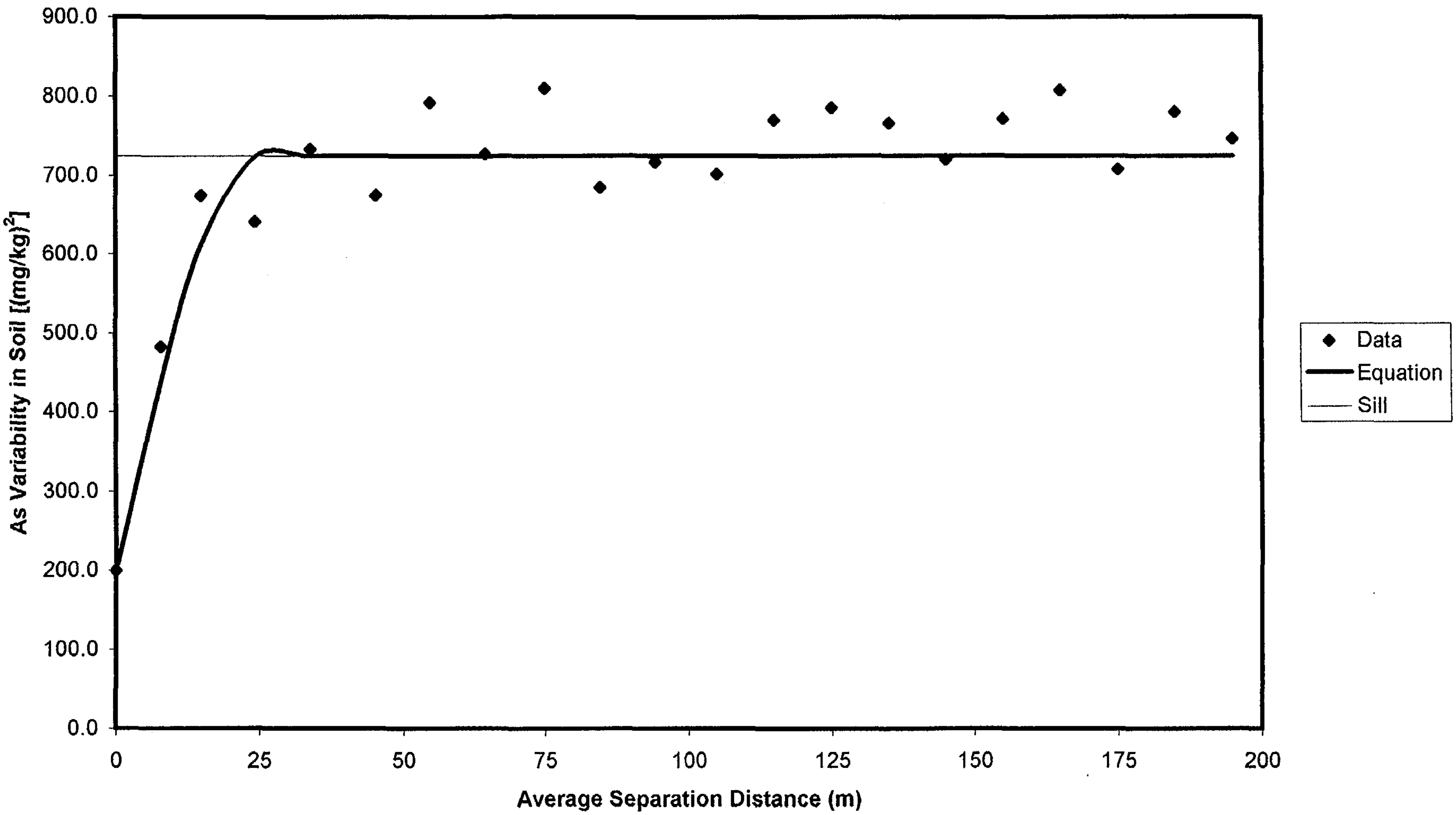


Figure 4-3a
Variogram for Lead
Major Axis of Continuity (East - West)

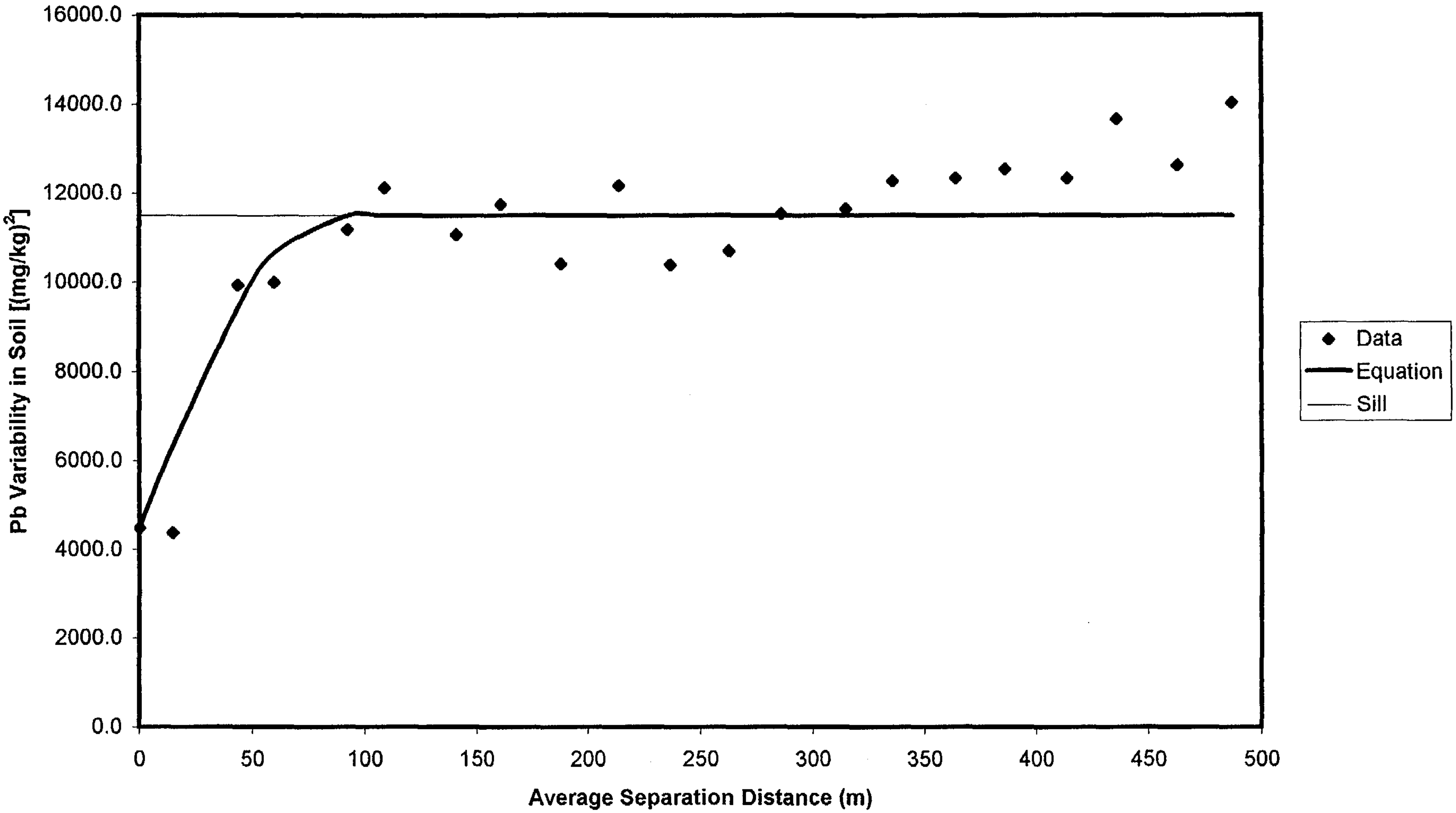
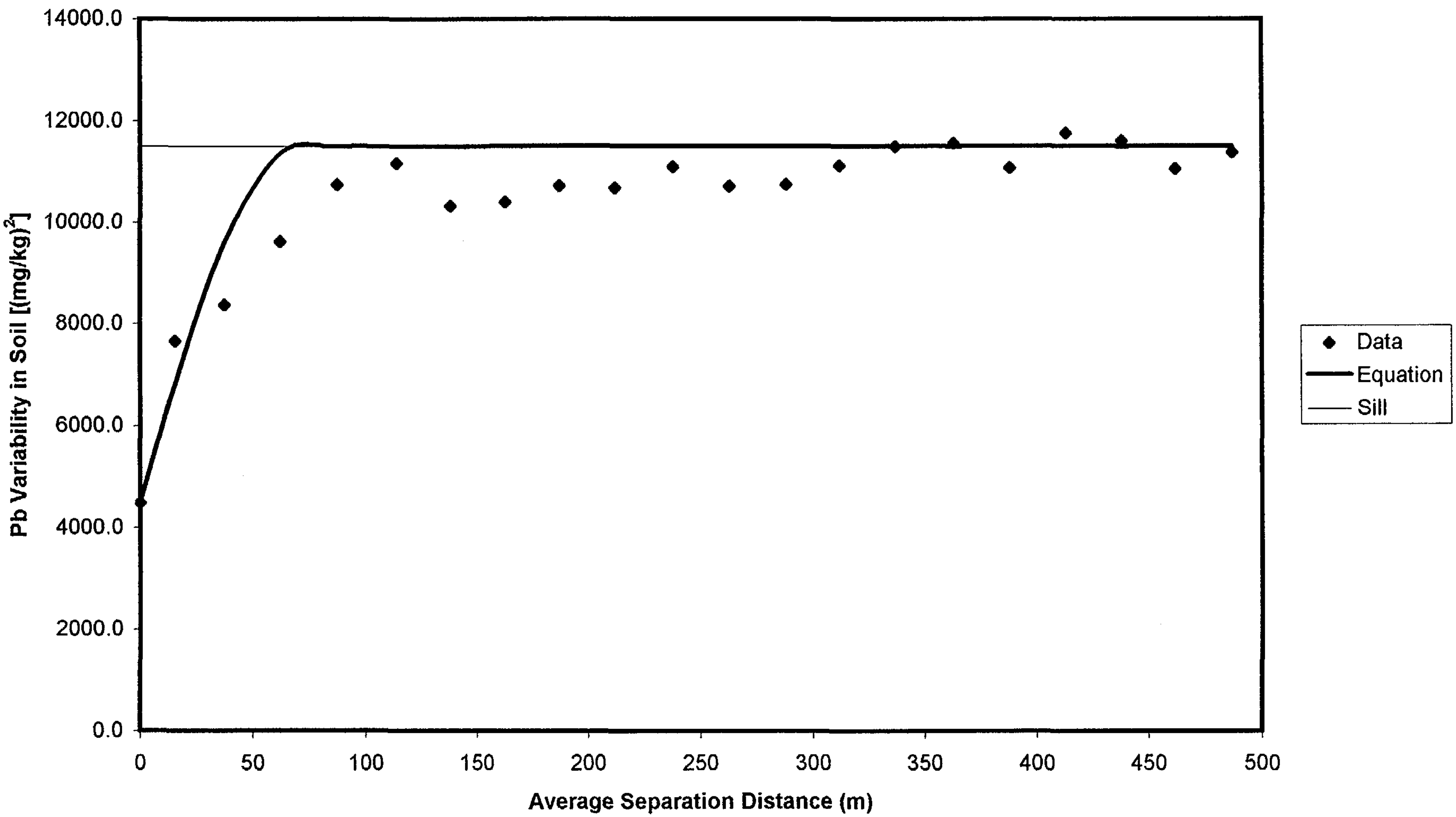
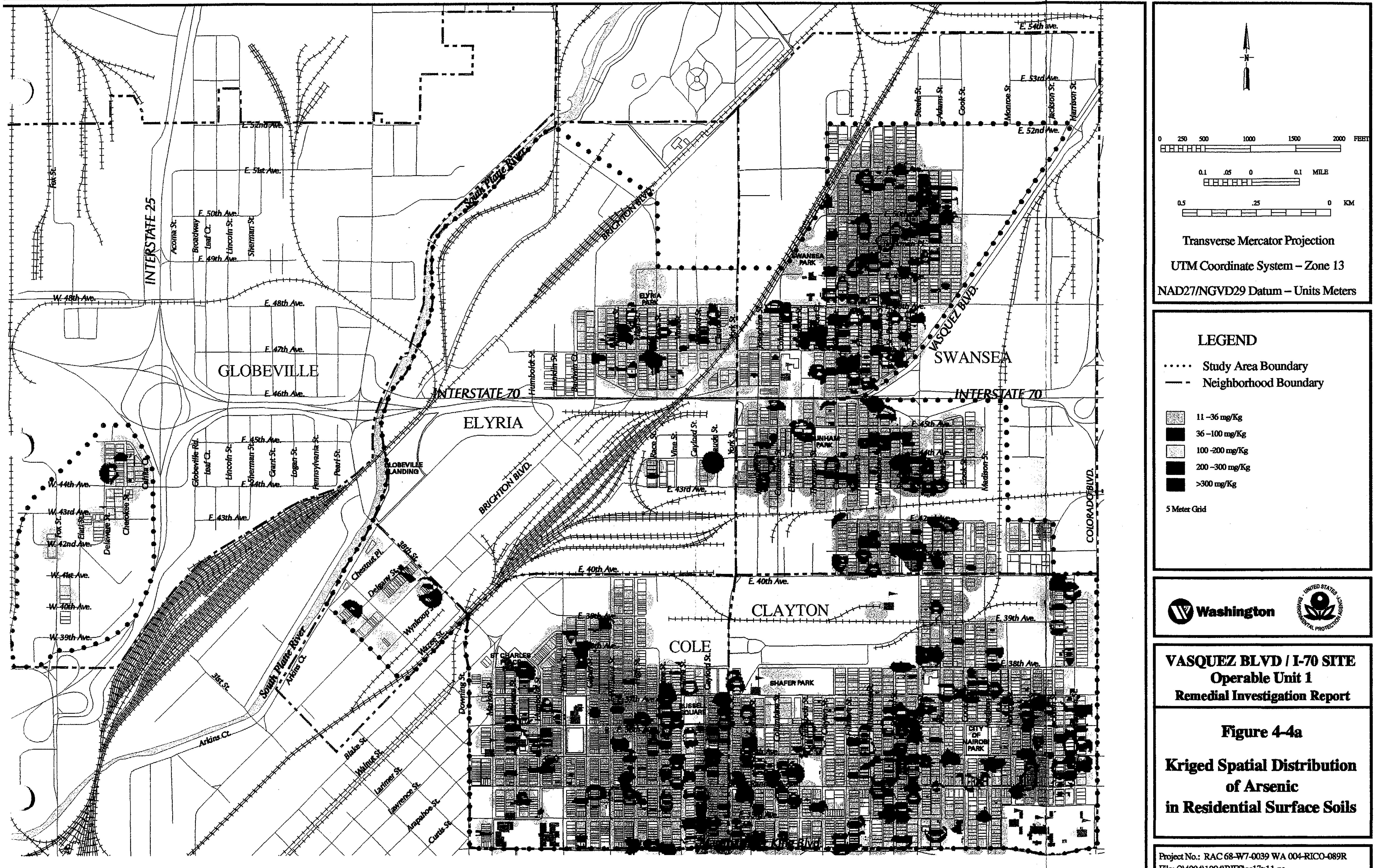


Figure 4-3b
Variogram for Lead
Minor Axis of Continuity (North-South)





VASQUEZ BLVD / I-70 SITE
Operable Unit 1
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Figure 4-4a

Kriged Spatial Distribution of Arsenic in Residential Surface Soils

Project No.: RAC 68-W7-0039 WA 004-RICO-089R
File: Q\4994\1004\RIFS\as17x11.ps
June 27, 2001

0 250 500 1000 1500 2000 FEET

0.1 .05 0 0.1 MILE

0.5 .25 0 KM

Transverse Mercator Projection

UTM Coordinate System – Zone 13

NAD27/NGVD29 Datum – Units Meters

LEGEND

Study Area Boundary

Neighborhood Boundary

52 – 173 mg/Kg

173 – 300 mg/Kg

300 – 400 mg/Kg

400 – 500 mg/Kg

>500 mg/Kg

5 Meter Grid

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United States Environmental Protection Agency

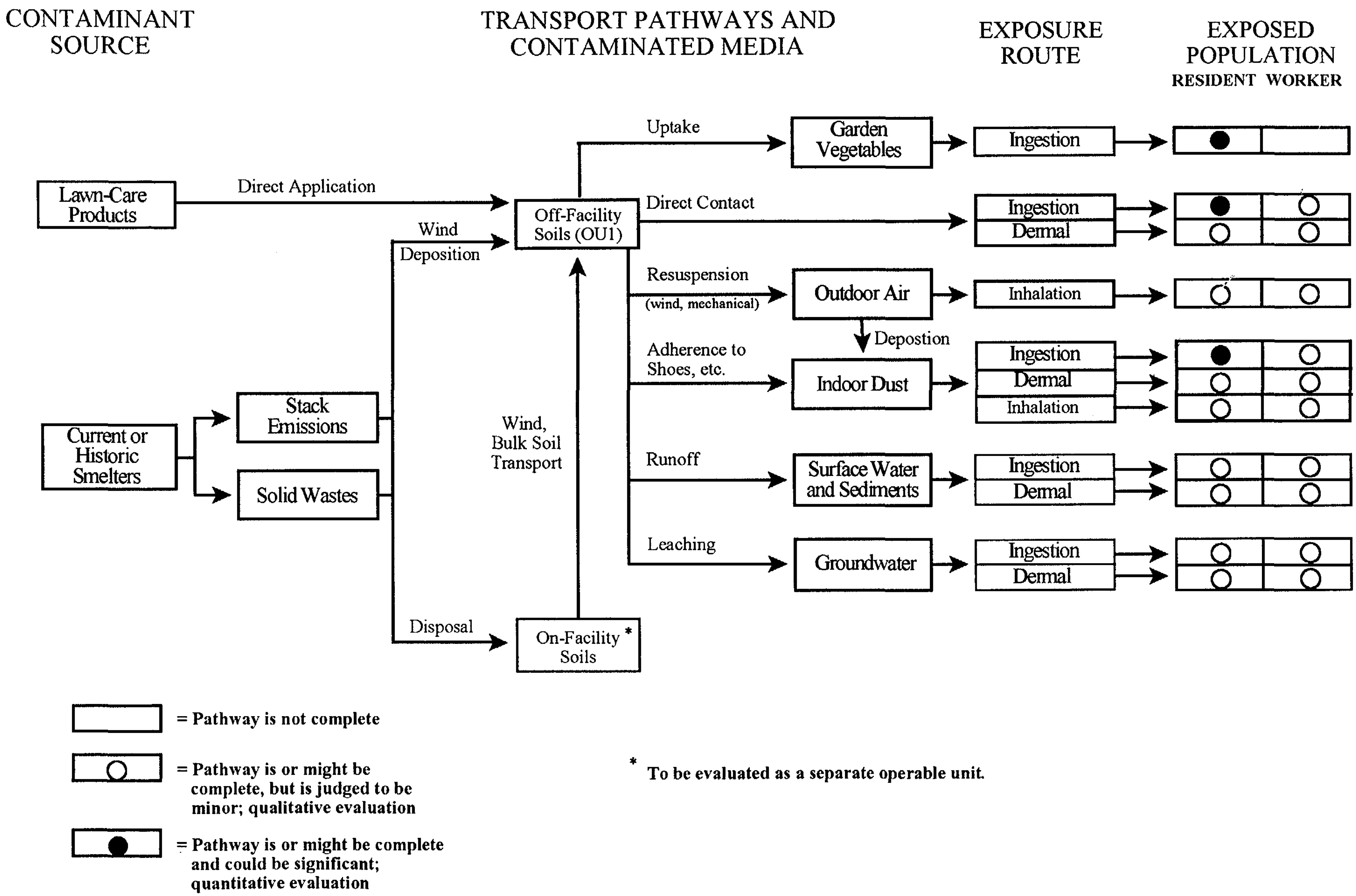
VASQUEZ BLVD / I-70 SITE
Operable Unit 1
Remedial Investigation Report

Figure 4-4b

Kriged Spatial Distribution of Lead in Residential Surface Soils

Project No.: RAC 68-W7-0039 WA 004-RICO-089R
File: Q\4994\1004\RIFS\pb17x11.ps
June 27, 2001

FIGURE 5-1 CONCEPTUAL SITE MODEL FOR OPERABLE UNIT 1
EXPOSURES TO OFF-FACILITY SOILS



Appendix

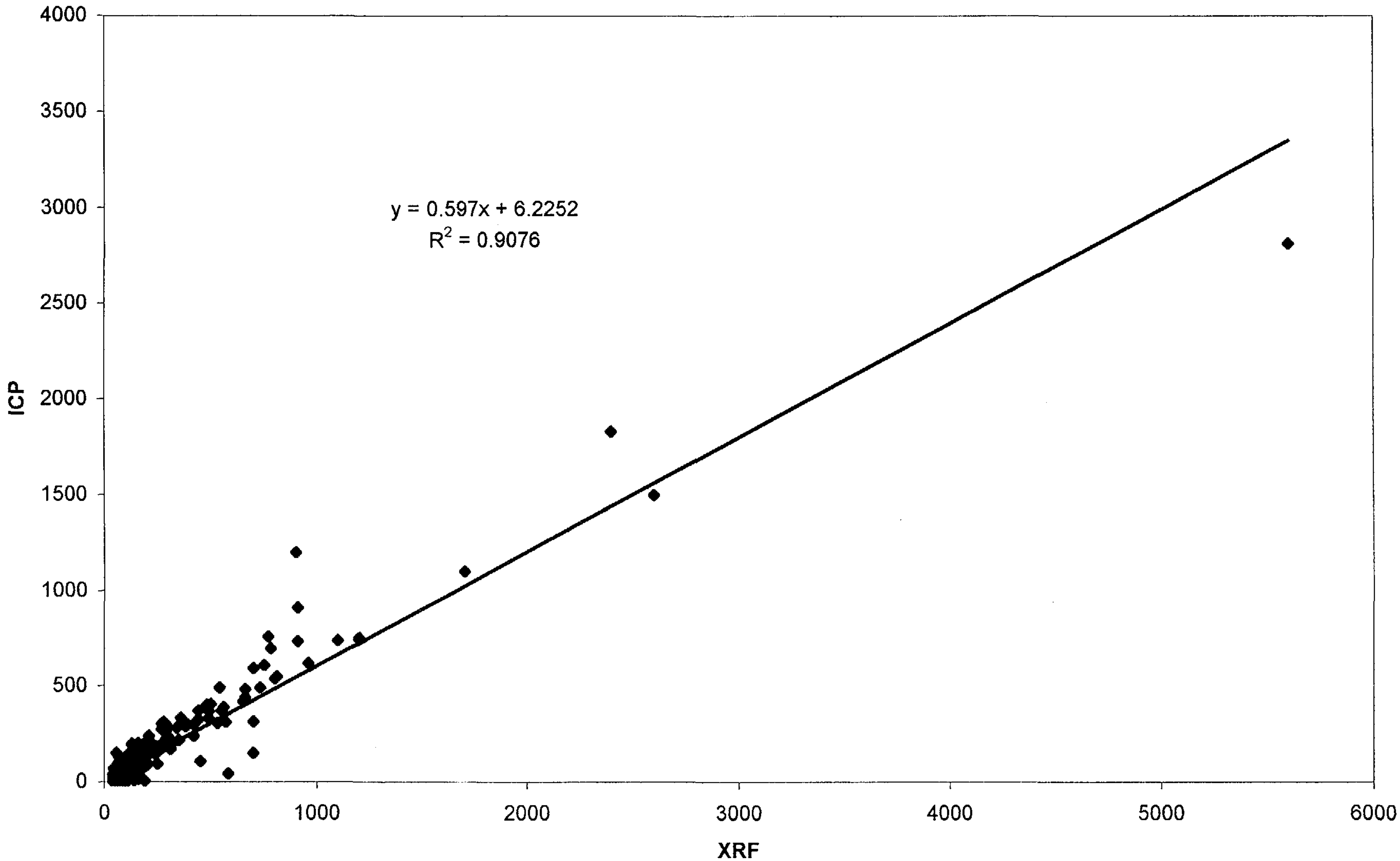
APPENDIX A

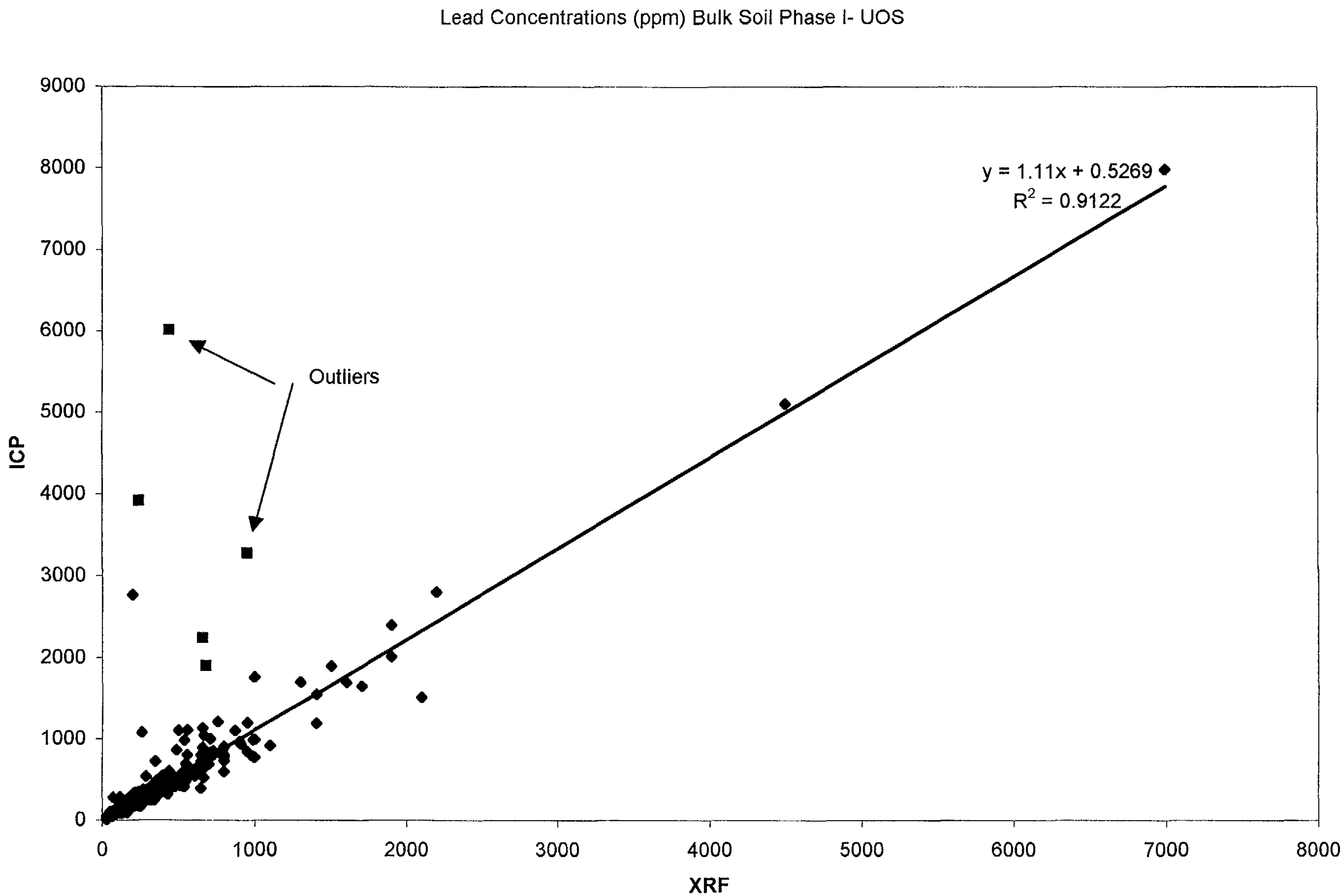
Data Quality Assurance/Quality Control

APPENDIX A1

Physico-Chemical Characterization
Comparison of Results for ICP vs. XRF

Arsenic Concentrations (ppm) Bulk Soils Phase I - UOS



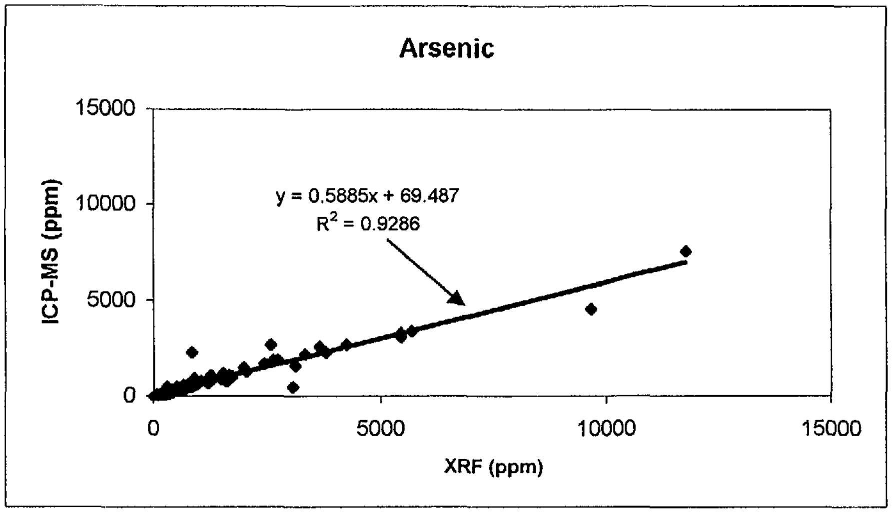


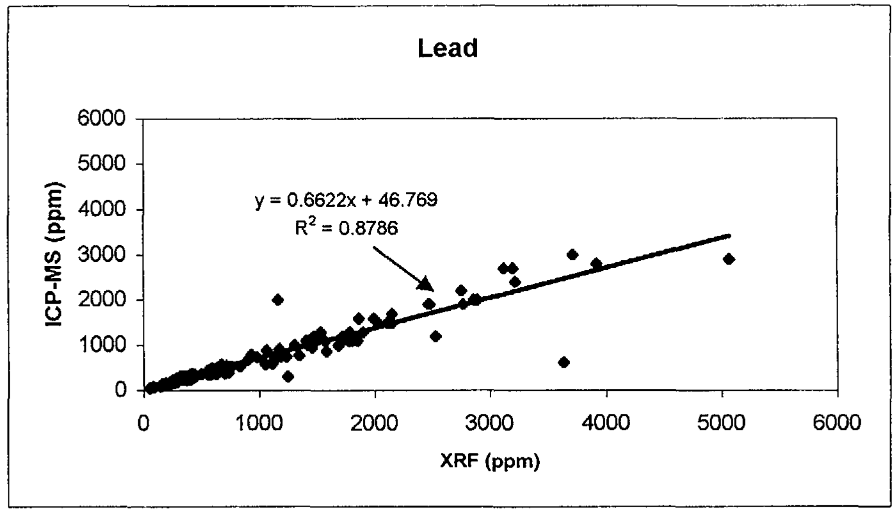
Lead Concentrations (ppm) Bulk Soil Phase I- UOS
y = 1.11x + 0.5269
R^2 = 0.9122
Outliers
ICP
XRF
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
0
1000
2000
3000
4000
5000
6000
7000
8000

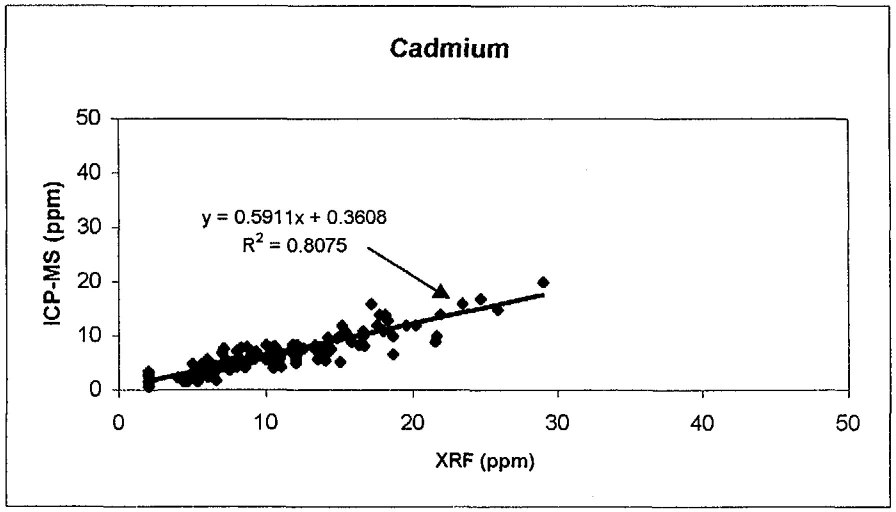
APPENDIX A2

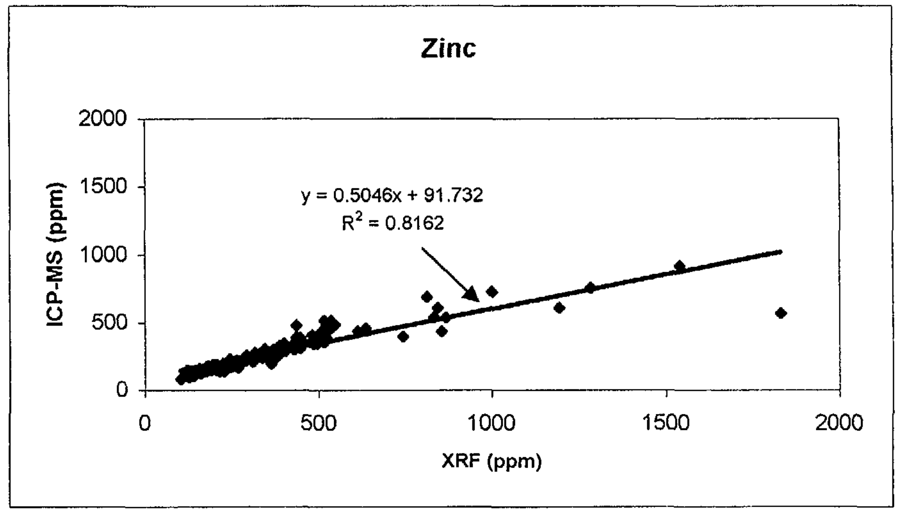
Residential Risk Based Sampling
Quality Assurance/Quality Control

Comparison of ICP and XRF for Confirmation Soil Samples

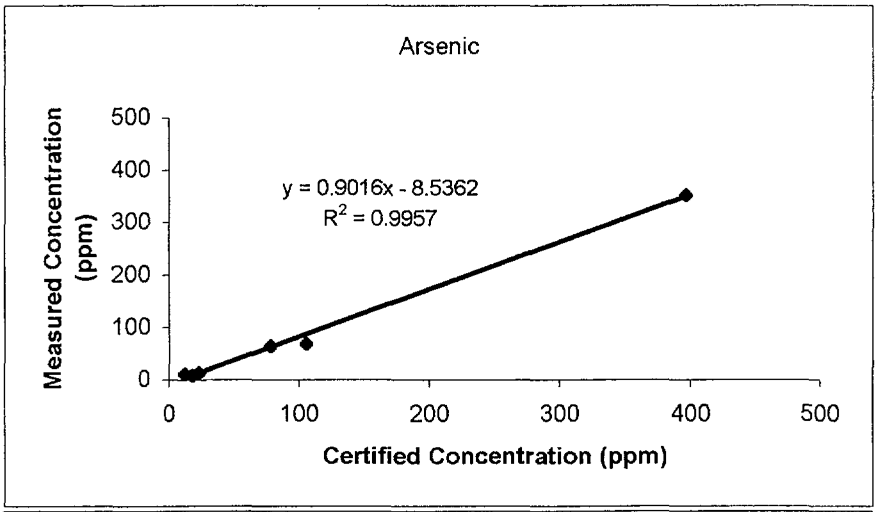


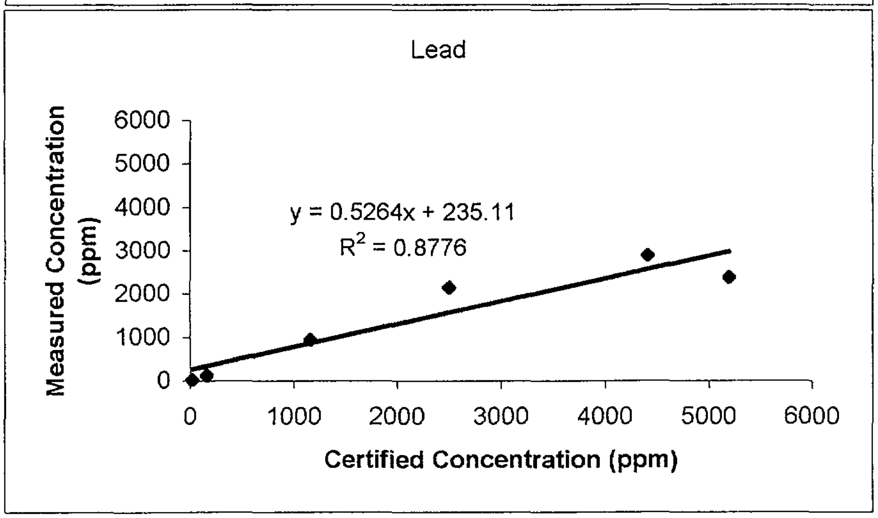


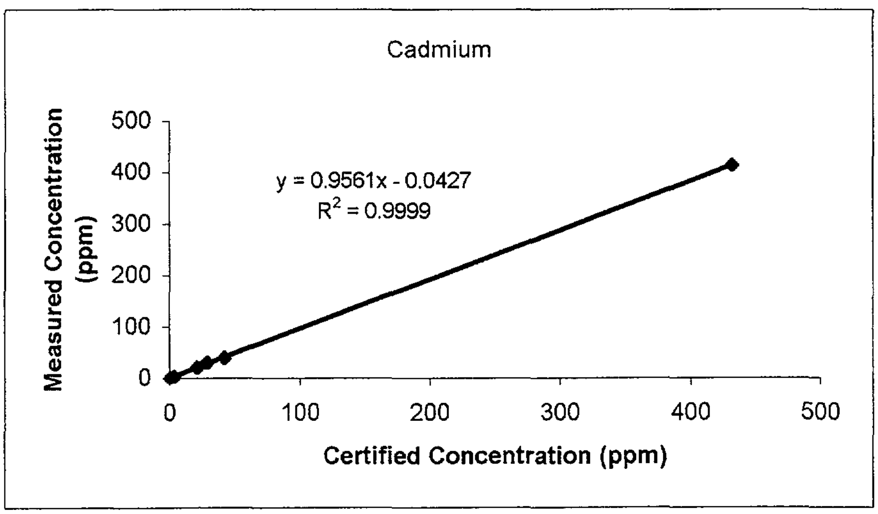




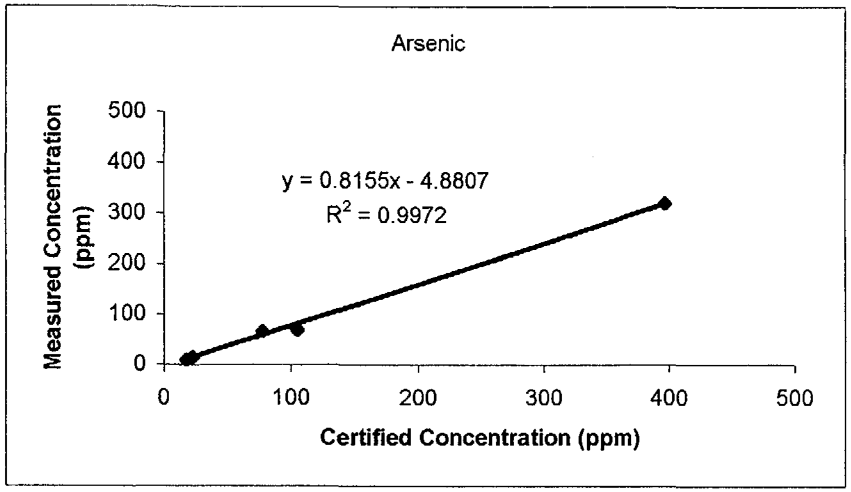
Blind QC Samples Analyzed with Unimpacted Soil Confirmation Samples

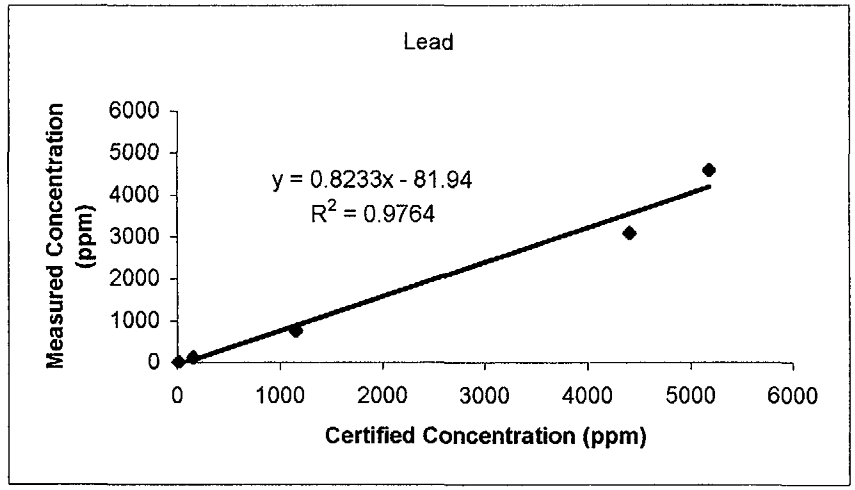


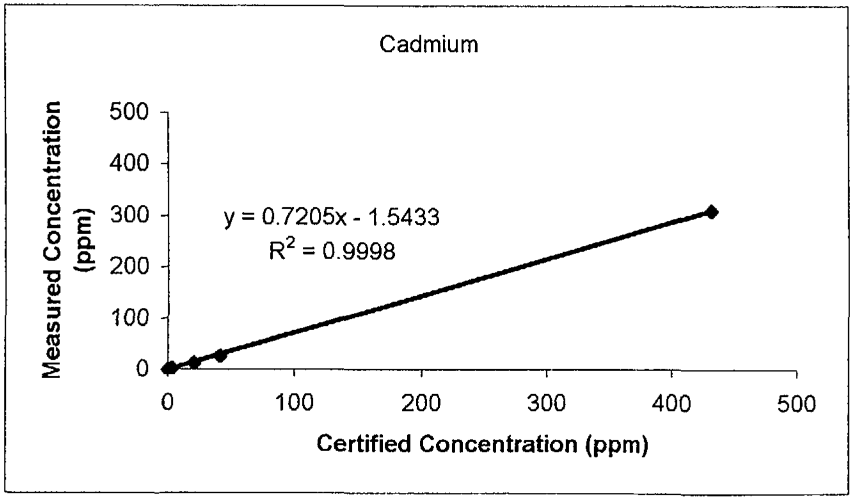


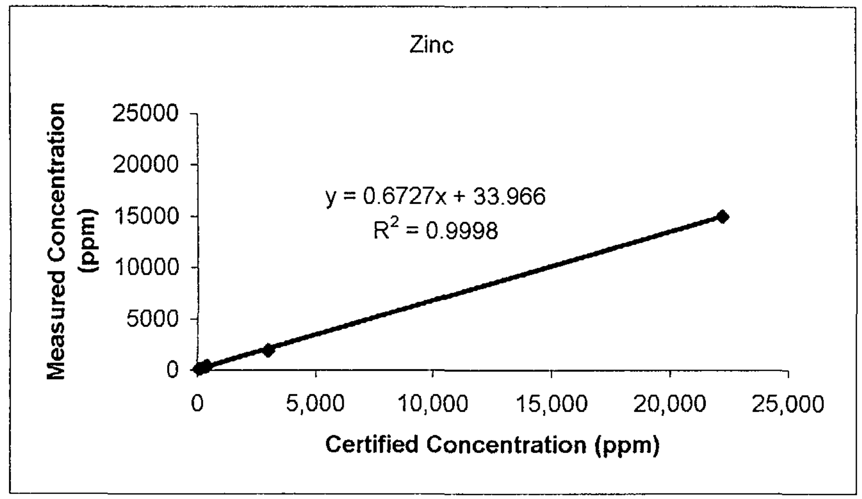


Blind QC Samples Analyzed with Impacted Soil Confirmation Samples

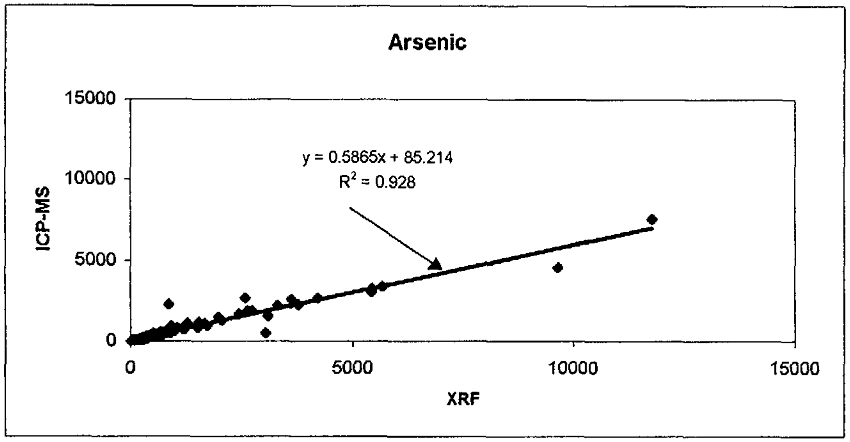


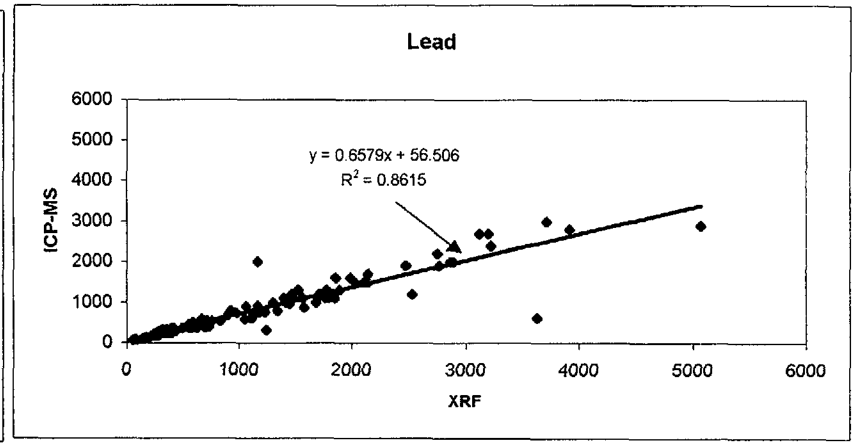


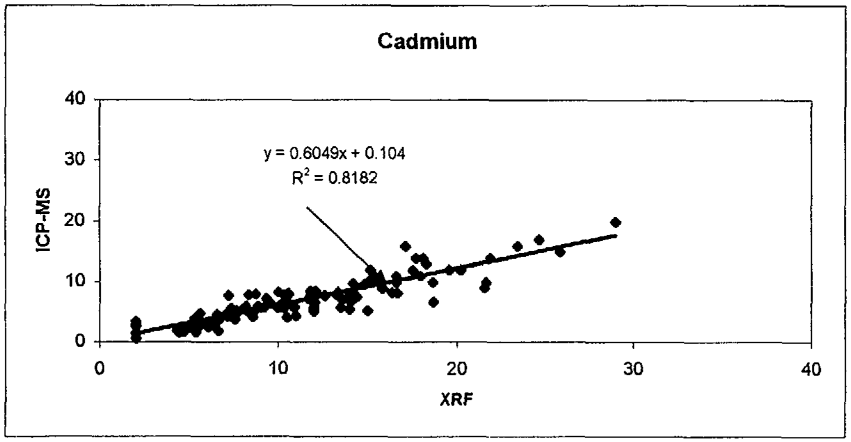


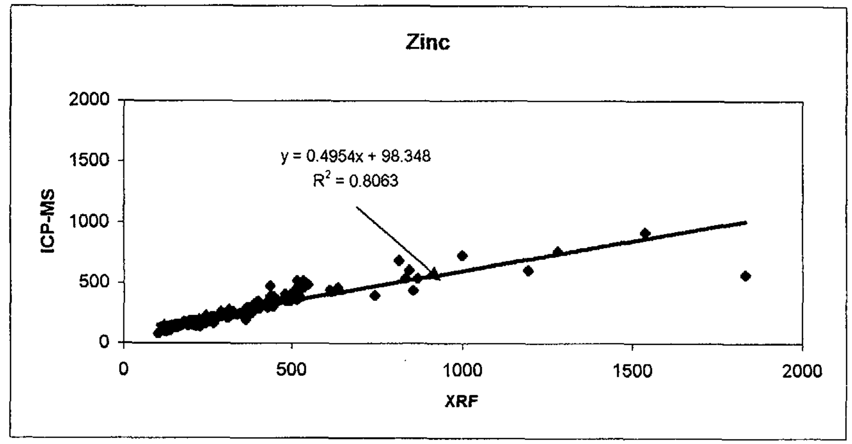


Comparison of ICP & XRF For Confirmation Soil Samples (Impacted)

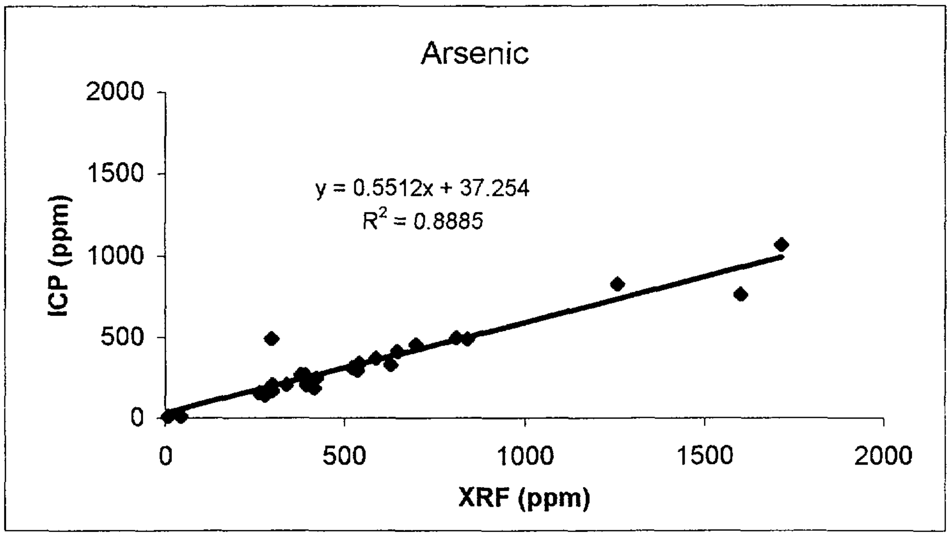


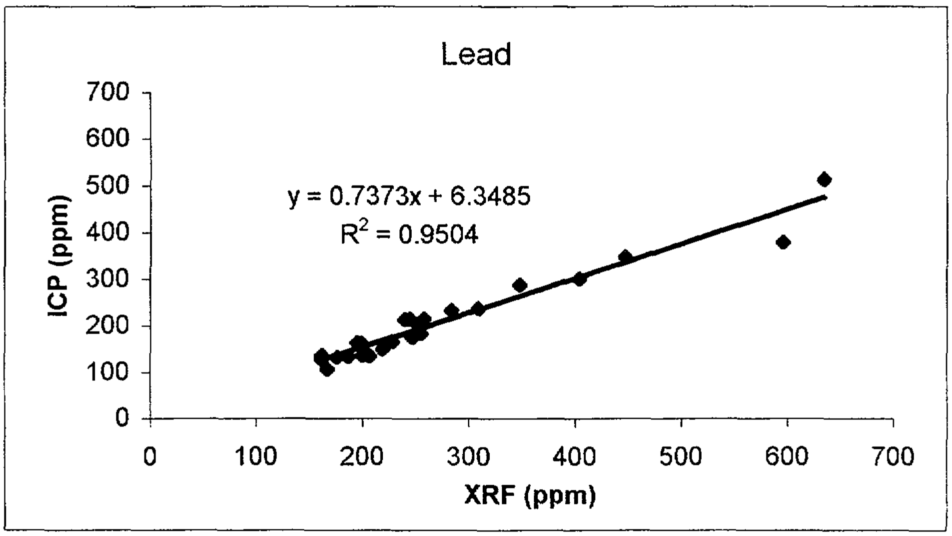






ICP vs XRF for Confirmation Soil Samples (Unimpacted)





Confirmation Soil Samples (Impacted)

Sample Number	Sample Type	ICP-MS (ppm)			
		As	Cd	Pb	Zn
ND-98-1009	Field	380	5.2	280	140
ND-98-1013	Field	170	2.4	150	140
ND-98-1015	Field	470	1.6	240	110
ND-98-1053	Field	16	2.6	170	300
ND-98-1071	Field	3300	14	1900	920
ND-98-1090	Field	350	5.3	370	230
ND-98-1105	Field	2600	12	3000	460
ND-98-1137	Field	510	6.7	620	400
ND-98-1162	Field	52	6.1	420	250
ND-98-1205	Field	760	7.9	1300	190
ND-98-1226	Field	89	7.6	750	300
ND-98-1249	Field	140	4.1	580	540
ND-98-1251	Field	380	6.4	780	540
ND-98-1252	Field	240	7.2	580	690
ND-98-1282	Field	2700	8.2	1100	520
ND-98-1283	Field	1600	12	1200	360
ND-98-1284	Field	2300	16	2000	440
ND-98-1291	Field	950	10	1000	610
ND-98-1304	Field	4600	15	2900	760
ND-98-1715	Field	2700	10	1300	220
ND-98-1721	Field	1000	5.5	730	140
ND-98-1725	Field	200	4.5	360	110
ND-98-1743	Field	2200	7.9	1500	190
ND-98-1759	Field	380	5.7	310	320
ND-98-1784	Field	3100	8.3	1100	200
ND-98-1786	Field	630	5.5	1100	180
ND-98-210	Field	590	9.8	790	330
ND-98-218	Field	1100	14	2700	390
ND-98-220	Field	290	8.5	550	270
ND-98-226	Field	1200	17	2200	410
ND-98-252	Field	140	6.6	300	300
ND-98-266	Field	520	7.2	680	300
ND-98-268	Field	46	5.8	290	350
ND-98-269	Field	38	4.4	310	570
ND-98-286	Field	160	2.5	220	150
ND-98-308	Field	370	4.2	330	200
ND-98-317	Field	20	0.67	57	99
ND-98-325	Field	340	6.8	290	180
ND-98-330	Field	570	6	370	170
ND-98-336	Field	1900	9	1000	290
ND-98-345	Field	1900	14	2700	400
ND-98-348	Field	57	2.8	220	230
ND-98-350	Field	370	11	920	410
ND-98-356	Field	490	4.9	450	240

Sample Number	Sample Type	ICP-MS (ppm)			
		As	Cd	Pb	Zn
ND-98-357	Field	1700	16	1600	490
ND-98-362	Field	310	8.1	890	350
ND-98-375	Field	590	10	1700	360
ND-98-381	Field	410	8.3	1500	280
ND-98-387	Field	820	6.7	1900	310
ND-98-389	Field	620	7.8	2000	290
ND-98-391	Field	1500	13	1900	390
ND-98-400	Field	940	12	2400	460
ND-98-414	Field	500	12	1600	440
ND-98-432	Field	420	2.9	330	140
ND-98-435	Field	95	1.9	110	83
ND-98-436	Field	420	2.9	220	140
ND-98-444	Field	370	1.7	240	130
ND-98-459	Field	370	5.8	530	210
ND-98-461	Field	170	5.8	870	240
ND-98-473	Field	180	4.8	140	180
ND-98-478	Field	240	6	230	180
ND-98-483	Field	290	7.6	270	190
ND-98-486	Field	230	5.4	360	220
ND-98-511	Field	29	1.6	80	120
ND-98-514	Field	63	3.3	230	230
ND-98-517	Field	750	7.8	1100	260
ND-98-520	Field	650	8.9	840	350
ND-98-551	Field	350	6	1200	220
ND-98-555	Field	300	4.6	890	190
ND-98-572	Field	520	7.6	1100	230
ND-98-585	Field	910	9.6	2800	350
ND-98-586	Field	540	8.3	1200	280
ND-98-607	Field	490	11	1100	390
ND-98-616	Field	400	5.7	530	350
ND-98-641	Field	2300	8	960	440
ND-98-649	Field	1300	8.5	740	200
ND-98-650	Field	13	4.3	270	160
ND-98-660	Field	710	20	1000	610
ND-98-686	Field	85	5.7	330	520
ND-98-703	Field	340	11	1300	360
ND-98-706	Field	19	4	280	430
ND-98-721	Field	73	4.3	270	150
ND-98-738	Field	55	3.9	240	180
ND-98-745	Field	25	2.1	130	200
ND-98-752	Field	350	7.6	390	260
ND-98-766	Field	340	2.8	1100	140
ND-98-782	Field	7600	10	1500	270
ND-98-784	Field	3400	10	2000	480
ND-98-792	Field	880	7	750	170
ND-98-793	Field	1100	11	1200	280

Sample Number	Sample Type	ICP-MS (ppm)			
		As	Cd	Pb	Zn
ND-98-819	Field	240	7.9	500	390
ND-98-825	Field	140	5.7	370	390
ND-98-837	Field	17	1.5	100	160
ND-98-842	Field	59	3.5	370	730
ND-98-859	Field	130	8	500	220
ND-98-880	Field	840	6.4	480	190
ND-98-887	Field	280	7.9	330	240
ND-98-888	Field	350	7.6	290	220
ND-98-899	Field	88	5.9	600	170
ND-98-933	Field	180	5.1	380	260
ND-98-943	Field	28	2.4	100	260
ND-98-946	Field	220	5.2	390	340
ND-98-960	Field	370	3.8	240	160
ND-98-977	Field	74	1.7	98	140
ND-98-987	Field	160	3.2	170	150
ND-98-991	Field	66	2.4	95	160
ND-98-994	Field	270	3.7	180	130
ND-98-998	Field	28	1.9	78	190
ND-98-2995	QC	67	310	3100	15000
ND-98-2998	QC	320	13	4600	1900
ND-98-3101	QC	70	26	770	320
ND-98-3125	QC	15	2.5	120	410
ND-98-3209	QC	10	0.2	160	120

QC - Quality Control Sample

Confirmation Soil Samples (Unimpacted)

Drexler Sample Number	Sample Type	XRF				ICP/ICPMS			
		As ppm	Cd ppm	Pb ppm	Zn ppm	As ppm	Cd ppm	Pb ppm	Zn ppm
ND-98-1989	Field	299	7	162	138	207	LA	136	LA
ND-98-1974	Field	698	10	245	157	456	LA	216	LA
ND-98-1977	Field	811	11	309	365	499	LA	238	LA
ND-98-2096	Field	535	14	447	242	296	LA	348	LA
ND-98-1946	Field	520	9	198	176	311	LA	155	LA
ND-98-1943	Field	586	7	404	385	372	LA	301	LA
ND-98-2048	Field	1600	16	596	381	764	LA	380	LA
ND-98-1959	Field	1716	8	348	214	1070	LA	288	LA
ND-98-1957	Field	1257	11	635	201	826	LA	513	LA
ND-98-1992	Field	647	7	284	207	412	LA	233	LA
ND-98-1948	Field	540	8	199	174	338	LA	163	LA
ND-98-1949	Field	391	8	258	214	265	LA	215	LA
ND-98-1960	Field	841	5	162	133	492	LA	128	LA
ND-98-1928	Field	297	9	195	176	490	LA	164	LA
ND-98-1882	Field	8	5	200	346	13	3.3	136	304
ND-98-1904	Field	421	7	247	219	248	6.9	176	181
ND-98-1956	Field	392	11	255	150	204	6.8	184	134
ND-98-1883	Field	261	9	219	206	157	6.3	150	166
ND-98-1894	Field	338	6	187	147	206	5.8	134	131
ND-98-1895	Field	414	8	167	115	186	4.3	107	110
ND-98-1918	Field	395	7	176	171	204	6.9	132	150
ND-98-1934	Field	299	9	207	176	166	6.4	135	148
ND-98-1941	Field	627	8	253	217	333	7.3	198	168
ND-98-1911	Field	279	7	246	177	141	4.8	177	139
ND-98-2034	Field	ND	4	240	194	10	2.4	214	173
ND-98-1990	Field	378	5	228	162	269	4.9	166	129
ND-98-3101	QC	105	42	1162	NP	69	38.4	931	307
ND-98-3125	QC	23	3	161	NP	13	2.9	122	394
ND-98-3209	QC	18	0	19	NP	9	ND	9	82
ND-98-2998	QC	397	21	5195	NP	353	20.0	2380	3220
ND-98-2995	QC	78	432	4414	NP	64	413.0	2900	19400
ND-98-3204	QC	12	29	2500	NP	11	30.1	2150	27000

LA = Lost Analysis
ND = Not Detected

Blind QC Results for Soil Confirmation Samples Analyzed via ICP-MS (Unimpacted Properties)

Drexler Sample ID	Standard Used	True Values Concentration (ppm)			Arsenic		Lead		Cadmium	
		As	Pb	Cd	C	%R	C	%R	C	%R
ND-98-2995	SRSO 19-50	78	4414	432	64.3	82.4	2900	65.7	413	95.6
ND-98-2998	CRM 020-50	397	5195	21	353	88.9	2380	45.8	20	95.2
ND-98-3101	NIST 2711	105	1162	42	69.3	66.0	931	80.1	38.4	91.4
ND-98-3125	NIST 2704	23	161	3.45	12.9	56.1	122	75.8	2.9	84.1
ND-98-3204	NIST 8604	12	2500	29	11.2	93.3	2150	86.0	30.1	103.8
ND-98-3209	NIST 2709	18	19	0.38	8.8	48.9	8.7	45.8	ND	--

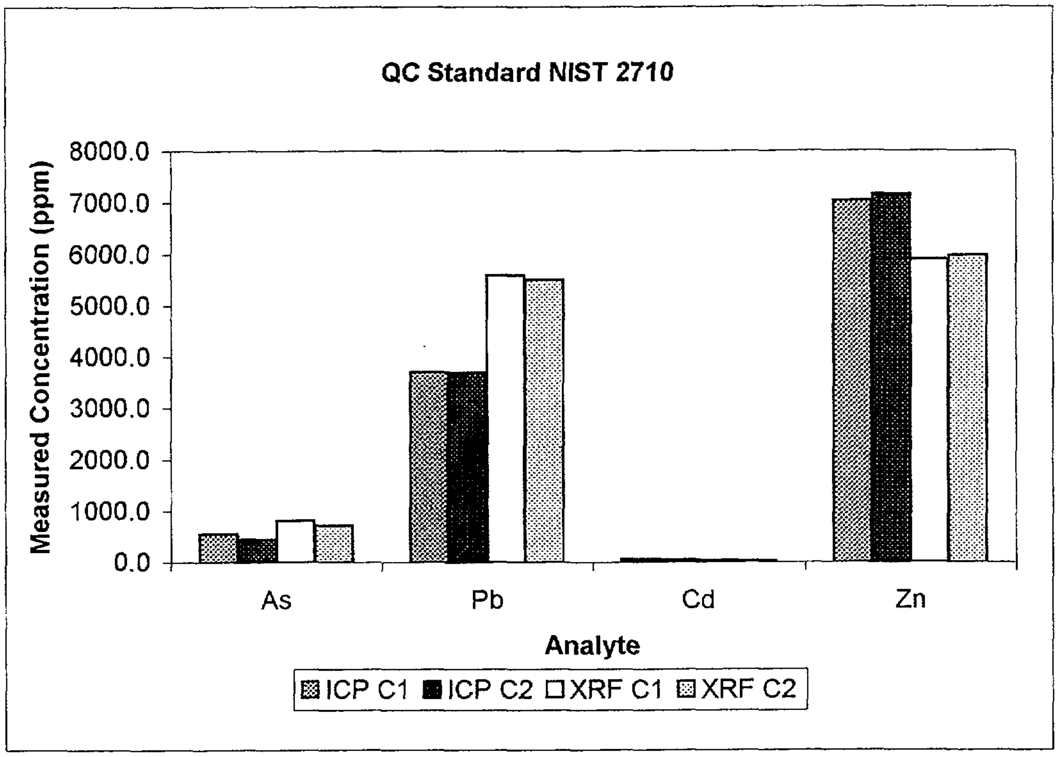
Blind QC Results for Soil Confirmation Samples Analyzed via ICP-MS (Impacted Properties)

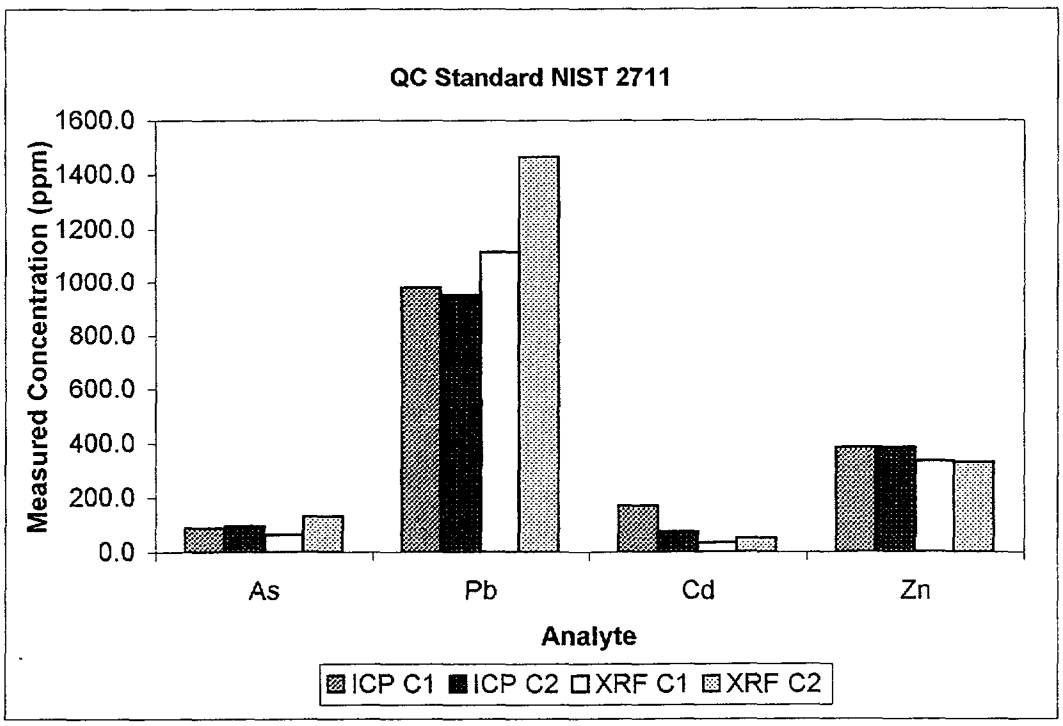
Drexler Sample ID	Standard Used	True Values Concentration (ppm)				Arsenic		Lead		Cadmium		Zinc	
		As	Pb	Cd	Zn	C	%R	C	%R	C	%R	C	%R
ND-98-2995	SRSO 19-50	78	4414	432	22,217	67	85.9	3100	70.2	310	71.8	15000	67.5
ND-98-2998	CRM 020-50	397	5195	21	3022	320	80.6	4600	88.5	13	61.9	1900	62.9
ND-98-3101	NIST 2711	105	1162	42	350	70	66.7	770	66.3	26	61.9	320	91.4
ND-98-3125	NIST 2704	23	161	3.45	438	15	65.2	120	74.5	2.5	72.5	410	93.6
ND-98-3209	NIST 2709	18	19	0.38	106	10	55.6	16	84.2	0.2	52.6	120	113.2

Comparison Between Laboratories

Drexler Sample ID	Standard Used	Relative Percent Difference (%)		
		As	Pb	Cd
ND-98-2995	SRSO 19-50	4.1	6.7	28.5
ND-98-2998	CRM 020-50	9.8	63.6	42.4
ND-98-3101	NIST 2711	1.0	18.9	38.5
ND-98-3125	NIST 2704	15.1	1.7	14.8
ND-98-3209	NIST 2709	12.8	12.8	--

Blind QC Results for Indoor Dust Samples





APPENDIX A3

Comparison of X-Ray Fluorescence to Other Analytical Methods

Comparison Of X-Ray Fluorescence To Other Analytical Methods

Purpose:

Analysis of soil samples at the VB/I-70 site have been performed using energy dispersive X-Ray Fluorescence (XRF) as the primary method, with Inductively Coupled Argon Plasma (ICP) as the confirmation method. Analysis by the two methods generally produce very similar values, however upon review of the Phase III sample results, a tendency for XRF results for site soils to be slightly higher than the ICP results was noted. (See Appendix A4- Data Quality Assessment for Phase IIIA Sampling Program Figure 17, Appendix A5- Data Quality Assessment for Phase IIIB Sampling Program Figure 21 and Appendix A6- Data Quality Assessment for Phase IIIB Grab Sampling Program Figure 21). This difference was not apparent for site-specific PE samples. (See Appendix A4 Figures 13 and 14, Appendix A5 Figures 15 and 16, and Appendix A6 Figures 15 and 16.) Since the XRF results tended to yield higher values than ICP results (see Figure 4), it was important to determine which method should be viewed as most nearly accurate. It was recommended that a set of soils, which were analyzed by both XRF and ICP, be analyzed by a third method: Neutron Activation Analysis (NAA). NAA is believed to be free of the potential limitations that may account for the difference between XRF and ICP. These limitations might include incomplete extraction, interference by lead, etc. The NAA results were expected to provide a basis for deciding which method should be considered the most accurate. Table 1 lists the soils re-submitted for NAA. The soil samples were chosen to represent a full range of arsenic concentrations and 16 were used in order to spread out the data points over the x-axis, giving a robust estimate of the slope.

Summary Of Results:

The re-submitted soils were analyzed for Neutron Activation Analysis (NAA) by Method NAS-1 in triplicate at Chemex, Inc. The results for XRF, ICP and NAA are reported in Table 1. The NAA results were compared to the PE nominal values (see Figure 1) and the NAA arsenic concentrations were clearly higher than the PE values for arsenic. The ICP results were compared to the NAA results (see Figure 2) and the ICP Arsenic concentrations were obviously lower than the NAA results. The XRF arsenic concentrations, however, compared well with the NAA results (see Figure 3). On the basis of comparison to NAA results, the arsenic concentrations in soil measured by energy dispersive XRF are considered to be the most accurate.

Table 1: Cross-Reference Table for Phase III Samples Re-submitted for NAA

Original Sample ID#	Aliquot #	Sample ID and Aliquot	NAA Sample ID#	Description/Source	Original As Concentration (ppm)		NAA Results		
					ICP	XRF	As (ppm)	Mean	Stdev
3-00205-B	1	3-00205-B-1	3-32	Phase 3			40		
3-00205-B	2	3-00205-B-2	3-38	Phase 3	33	43	41	41	1.0
3-00205-B	3	3-00205-B-3	3-42	Phase 3			42		
3-00698-B	1	3-00698-B-1	3-20	Phase 3			495		
3-00698-B	2	3-00698-B-2	3-05	Phase 3	420	497	471	469	26.5
3-00698-B	3	3-00698-B-3	3-16	Phase 3			442		
3-02318-B	1	3-02318-B-1	3-40	Phase 3			241		
3-02318-B	2	3-02318-B-2	3-02	Phase 3	224	226	227	228	13.0
3-02318-B	3	3-02318-B-3	3-37	Phase 3			215		
3-02319-B	1	3-02319-B-1	3-24	Phase 3			422		
3-02319-B	2	3-02319-B-2	3-25	Phase 3	310	422	409	418	7.8
3-02319-B	3	3-02319-B-3	3-01	Phase 3			423		
3-02593-B	1	3-02593-B-1	3-29	Phase 3			151		
3-02593-B	2	3-02593-B-2	3-44	Phase 3	113	153	150	152	3.2
3-02593-B	3	3-02593-B-3	3-35	Phase 3			156		
3-02950-B	1	3-02950-B-1	3-27	Phase 3			117		
3-02950-B	2	3-02950-B-2	3-31	Phase 3	70	106	134	121	11.5
3-02950-B	3	3-02950-B-3	3-19	Phase 3			112		
B1-00001-F	1	B1-00001-F-1	3-08	Swine Bioavailability/Test Material 1			332		
B1-00001-F	2	B1-00001-F-2	3-11	Swine Bioavailability/Test Material 1	289.5	313	320	328	6.7
B1-00001-F	3	B1-00001-F-3	3-18	Swine Bioavailability/Test Material 1			331		
B1-00002-F	1	B1-00002-F-1	3-48	Swine Bioavailability/Test Material 2			1010		
B1-00002-F	2	B1-00002-F-2	3-09	Swine Bioavailability/Test Material 2	856	1041	1090	1053	40.4
B1-00002-F	3	B1-00002-F-3	3-26	Swine Bioavailability/Test Material 2			1060		
B1-00003-F	1	B1-00003-F-1	3-47	Swine Bioavailability/Test Material 3			403		
B1-00003-F	2	B1-00003-F-2	3-45	Swine Bioavailability/Test Material 3	342.5	419	412	408	4.6
B1-00003-F	3	B1-00003-F-3	3-14	Swine Bioavailability/Test Material 3			409		
B1-00004-F	1	B1-00004-F-1	3-39	Swine Bioavailability/Test Material 4			825		
B1-00004-F	2	B1-00004-F-2	3-28	Swine Bioavailability/Test Material 4	756	821	878	862	31.8
B1-00004-F	3	B1-00004-F-3	3-03	Swine Bioavailability/Test Material 4			882		
B1-00005-F	1	B1-00005-F-1	3-36	Swine Bioavailability/Test Material 5			419		
B1-00005-F	2	B1-00005-F-2	3-23	Swine Bioavailability/Test Material 5	329	352	416	423	9.6
B1-00005-F	3	B1-00005-F-3	3-21	Swine Bioavailability/Test Material 5			434		
B1-00006-F	1	B1-00006-F-1	3-04	Swine Bioavailability/Test Material 6			622		
B1-00006-F	2	B1-00006-F-2	3-30	Swine Bioavailability/Test Material 6	459	503	547	586	37.6
B1-00006-F	3	B1-00006-F-3	3-07	Swine Bioavailability/Test Material 6			589		
Standard A	1	Standard A-1	3-22	Soil Spikes/PE Samples			50		
Standard A	2	Standard A-2	3-46	Soil Spikes/PE Samples	--	51	49	50	0.6
Standard A	3	Standard A-3	3-41	Soil Spikes/PE Samples			50		
Standard B	1	Standard B-1	3-33	Soil Spikes/PE Samples			174		
Standard B	2	Standard B-2	3-15	Soil Spikes/PE Samples	--	144	189	186	10.4
Standard B	3	Standard B-3	3-06	Soil Spikes/PE Samples			194		
Standard C	1	Standard C-1	3-34	Soil Spikes/PE Samples			375		
Standard C	2	Standard C-2	3-13	Soil Spikes/PE Samples	--	304	400	391	13.7
Standard C	3	Standard C-3	3-43	Soil Spikes/PE Samples			397		
Standard D	1	Standard D-1	3-17	Soil Spikes/PE Samples			979		
Standard D	2	Standard D-2	3-12	Soil Spikes/PE Samples	--	881	1020	1030	56.1
Standard D	3	Standard D-3	3-10	Soil Spikes/PE Samples			1090		

Figure 1: Neutron Activation Analysis (NAA) VS PE Nominal Values

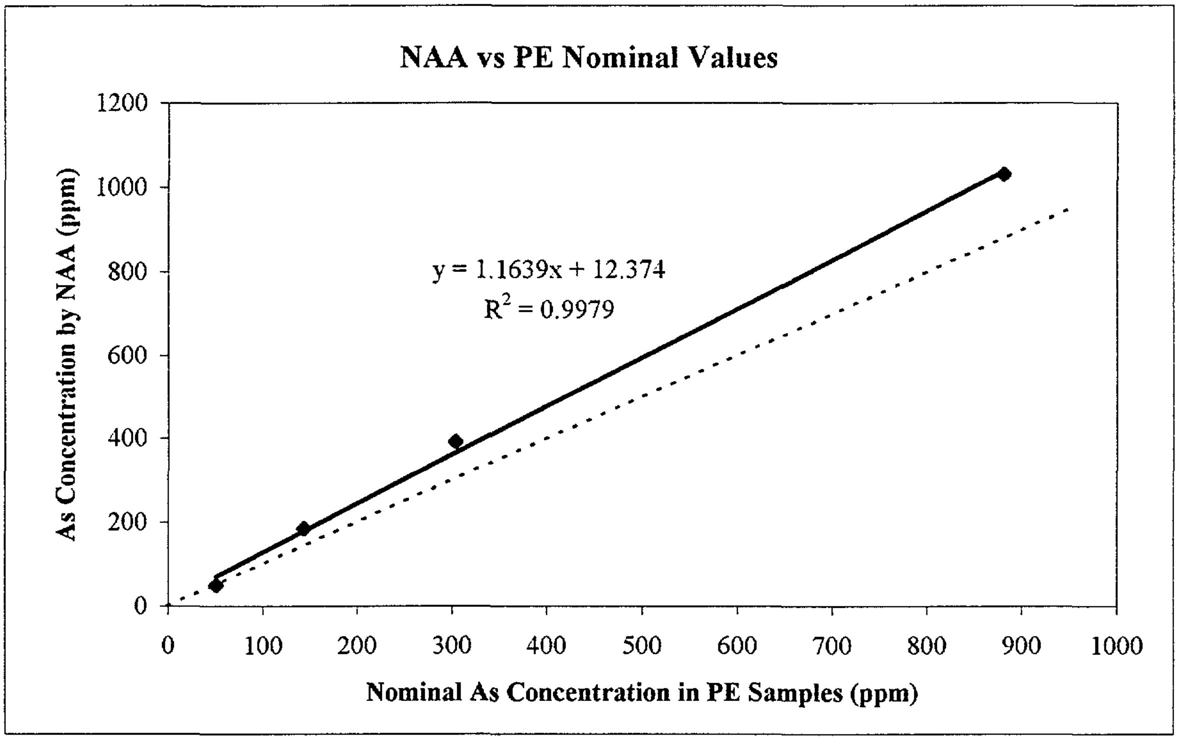


Figure 2: Inductively Coupled Argon Plasma (ICP) VS NAA

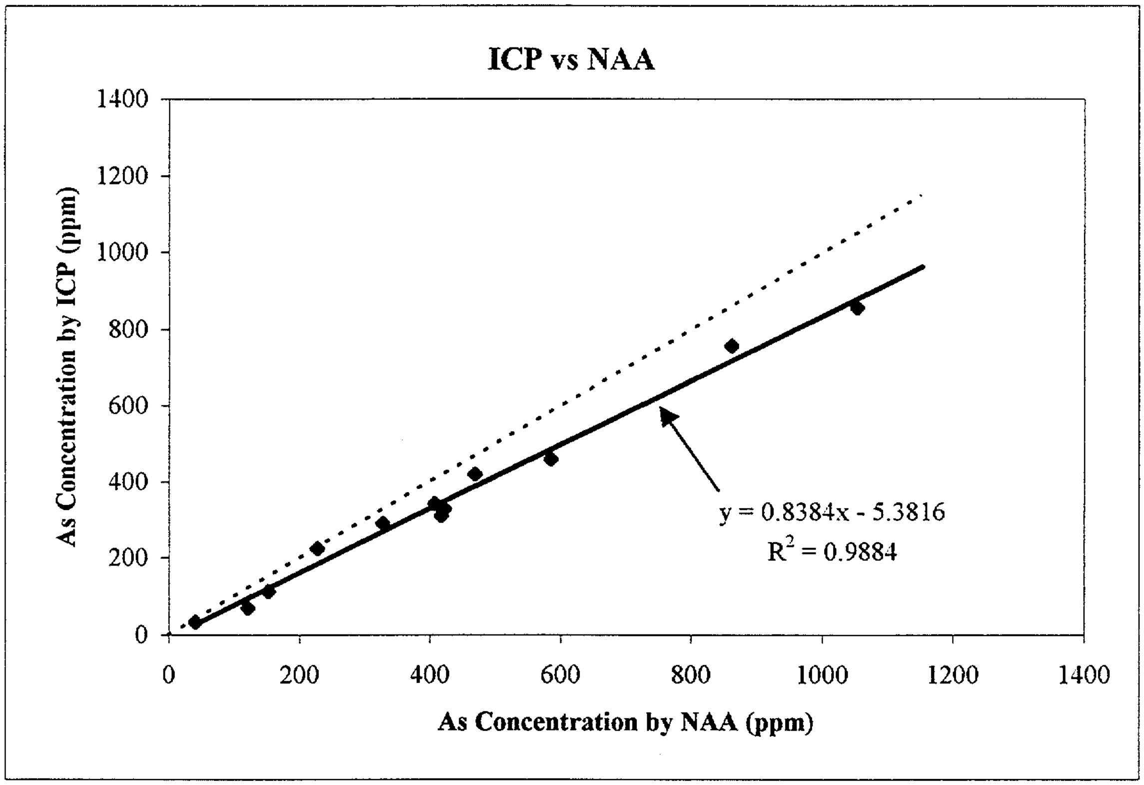


Figure 3: X-Ray Fluorescence (XRF) VS Neutron Activation Analysis (NAA)

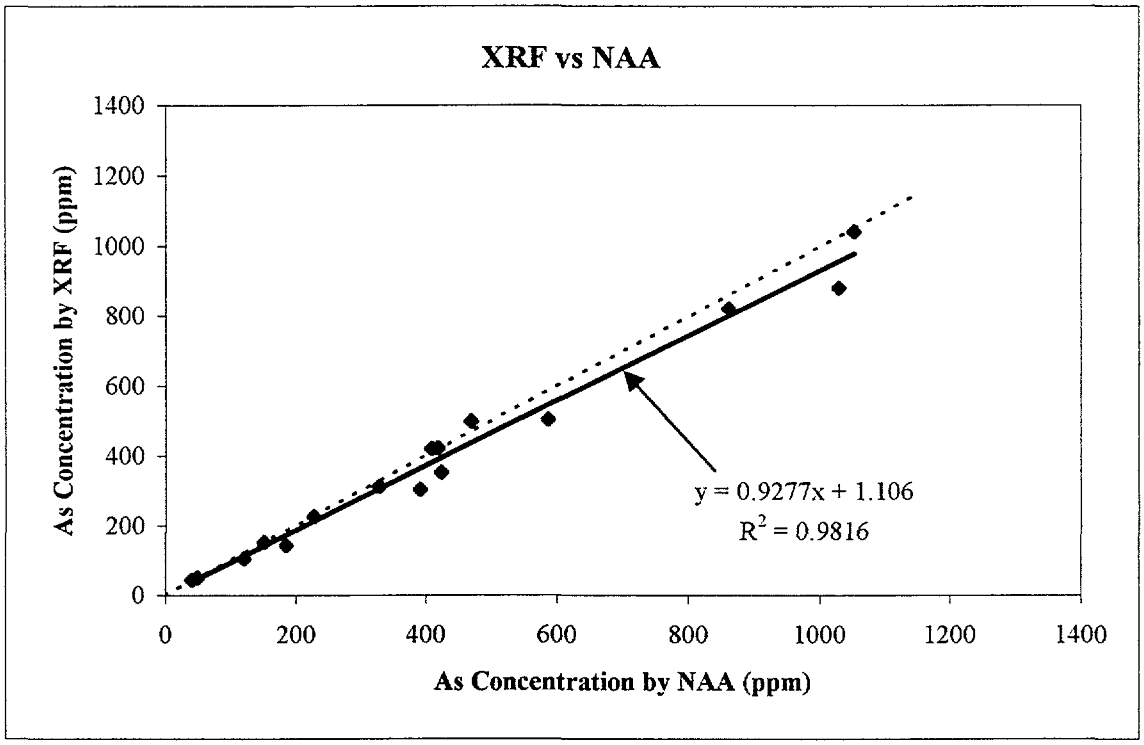
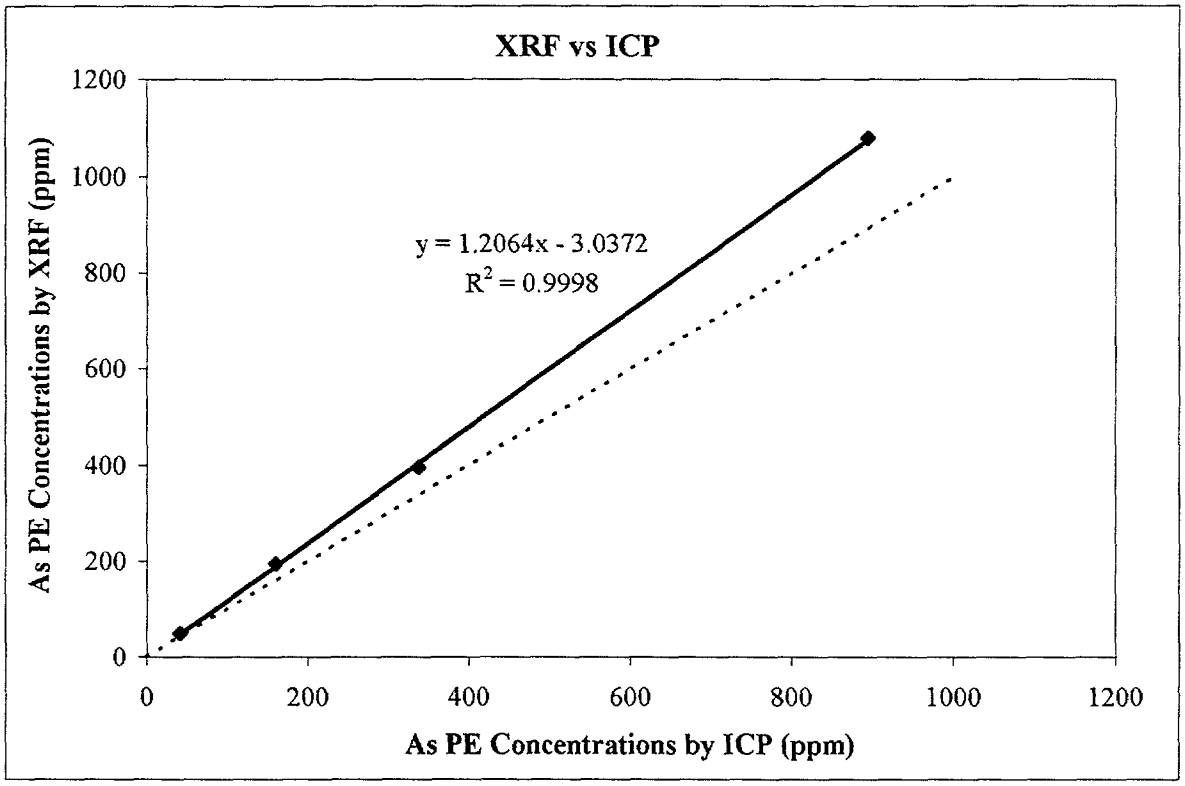


Figure 4: Average PE Results for XRF VS ICP



APPENDIX A4

Data Quality Assessment
Phase IIIA Sampling Program

DATA QUALITY ASSESSMENT
PHASE IIIA SAMPLING PROGRAM

VASQUEZ BOULEVARD AND I-70 REMEDIAL INVESTIGATION

FINAL
JULY 21, 2000

Prepared for

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Region VIII

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1.0 OVERVIEW

Chemical analysis of the Vasquez Boulevard/Interstate 70 (VB/I-70) Phase IIIA site characterization samples was conducted under a comprehensive quality assurance program. The program included requirements for the collection, preparation, and analysis of quality control samples, as specified in the Project Plan for the Vasquez Boulevard & I-70 Site, Phase III Field Investigation (ISSI, 08/04/99), Section 4.0 Quality Assurance Project Plan (QAPP), and related Standard Operating Procedures for sample collection, preparation and analysis.

An assessment of the data quality was performed daily throughout the program to verify compliance with the quality control criteria and to identify necessary corrective actions. An assessment of all Phase IIIA data, including residential surface soil, garden soil, garden vegetables and indoor dust, has been performed to verify that the data set is consistent with and meets the data quality objectives identified in the QAPP. The data quality assessment is presented in terms of the precision, accuracy, representativeness, comparability, and completeness of the data. The results document that the data are usable for their intended purpose of identifying average surface soil concentrations and supporting the Baseline Risk Assessment.

2.0 SOIL SAMPLE DATA QUALITY

Soil samples were collected from residential yards, vegetable gardens, schools, and one park. All soil samples were prepared in the field laboratory by homogenizing the sample, drying a portion of the sample, sieving the sample through a #10 sieve, and then grinding a portion of the sieved, bulk fraction. The ground sample was analyzed at the field laboratory using a QuanX Energy Dispersive X-Ray Fluorescence Spectrometer (XRF). A percentage of samples were split and also submitted for off-site laboratory analysis.

Quality control sample results for soils analyzed by XRF are charted in Figures 1 through 17. Table 1 summarizes the number of soil field samples and each type of quality control sample.

2.1 <u>Precision</u>

Precision measures the reproducibility of values under a given set of conditions. Precision was measured in Phase IIIA soils through preparation and analysis of laboratory duplicates and blind split samples.

2.1.1 Laboratory Duplicates

Laboratory duplicates were prepared and analyzed at a frequency of one for every twenty field samples. Laboratory duplicates were identifiable to the analyst so that the duplicate and original field sample results could be reviewed immediately following analysis. The results of the laboratory duplicates are presented in Figures 1 through 4. Duplicates met the quality control criteria of less than 25% relative percent difference between the original sample and its duplicate, or less than one method detection limit (MDL) for samples with concentrations less than five times the MDL, in all but four samples for arsenic and three samples for lead. The results for samples associated with the preparation of these seven duplicates exceeding the precision criteria were qualified as estimated. Overall correlation of original samples versus duplicates was very good.

2.1.2 Blind Splits

Blind split samples were prepared at the same frequency and in the same manner as laboratory duplicates, but were assigned a unique sample identification number and submitted blind to the analyst such that it could not be distinguished from other field samples. The results of the blind splits are presented in Figures 5 through 8. Blind splits met the quality control criteria of less than 25% relative percent difference between the original sample and its split, or less than one MDL for samples with concentrations less than five times the MDL, in all but five samples for arsenic and three samples for lead. The results for samples associated with the preparation of these eight blind splits exceeding the precision criteria were qualified as estimated. Overall correlation of original samples versus blind splits was very good.

2.2 <u>Accuracy</u>

Accuracy measures the bias from the true value in a measurement system. Analytical accuracy was evaluated in soils through determination of the arsenic and lead MDLs, instrument calibration using certified standard reference materials (SRM), and analysis of blind standards.

2.2.1 Method Detection Limit Study

The MDL is the lowest concentration of a substance that can be measured and reported with a 99% confidence that the analyte is present. Instrument- and matrix-specific MDLs were determined in Phase IIIA for arsenic and lead. MDL studies were conducted prior to XRF analysis of field samples, and periodically throughout the program. Seven aliquots each of 27 samples were analyzed throughout Phase IIIA, and provisional MDLs were calculated equal to three times the standard deviation of each set of seven values. The final Phase IIIA MDLs were calculated as three times the pooled variance of the MDL test results. The Practical Quantitation Limit (PQL) is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The PQLs for arsenic and lead were calculated as ten times the pooled variance of the MDL test results. Values reported between the MDL and PQL are considered estimated concentrations.

Analyte	MDL (mg/kg)	PQL (mg/kg)
Arsenic	11	36
Lead	52	173

2.2.2 Instrument Calibration

Analytical accuracy was achieved through XRF instrument calibration and re-standardization, supplemented with:

- Daily energy calibration check
- Daily initial calibration verification through analysis of three or more SRMs with certified concentrations provided by the National Institute of Standards and Technology (NIST)
- Continuing calibration verification by analysis of one SRM with each analytical batch

The NIST SRM results are presented in Figures 9 through 12. If a NIST standard exceeded the control limit, then data for samples analyzed with that standard were rejected and the analytical batch was re-analyzed. A small number of NIST 2704 and NIST 2709 standards shown in Figure 9 exceed the final criteria because the criteria at the time of analysis was based on plus or minus one MDL, and the provisional arsenic MDL of 12 mg/kg was in use.

2.2.3 Blind Standards

Accuracy also was measured by submitting blind standards for analysis. These standards were contained and labeled in the same manner as field samples, and therefore the analyst could not identify them as quality control standards. Nominal values for six lots (Lots A - F) were established through multiple analyses of subsamples from the lot. A slightly higher degree of variability is expected for the blind standards as compared to the NIST standards used in the calibration verification because the blind standards prepared for this program did not have certified concentrations and the matrix was more variable. The blind standards results are presented in Figures 13 through 16.

2.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic or condition, and is achieved through proper design of a sampling program. Representativeness of soil samples has been assessed through preparation and analysis of blanks, comparison of field duplicates, and intra-sample variability tests.

2.3.1 Instrument and Method Blanks

Instrument blanks consisting of clean sand were run with each analytical batch. Method blanks consisted of clean sand that was processed through the entire laboratory preparation and analytical procedures on a daily basis. Instrument and method blank results all were below the MDLs and demonstrate that cross contamination did not occur between samples within the field laboratory.

2.3.2 Rinse Blanks

Rinse blanks were prepared by rinsing decontaminated soil sampling equipment (augers, trowels, and bowls) with deionized water and collecting the rinsate for analysis. Rinse blanks were collected at a frequency of 3.5% of the field samples, which is less than the 5% (one for every twenty field samples) stated in the QAPP. However, neither arsenic nor lead were reported present in any of the 174 rinse blanks collected, which demonstrates effective decontamination of soil sampling equipment.

2.3.3 Field Duplicates

Three field duplicates were collected for the garden soil samples and eleven field duplicates were collected from schoolyard samples. In garden soils, two of the arsenic and all three pairs of lead values were greater than the MDL. The relative percent differences between the original field sample and its duplicate for lead were 0%, 1% and 41%. The relative percent differences for arsenic were less than one MDL and 52%. The results associated with the original and duplicate samples that exceed the control criteria of 25% were qualified as estimated.

In schoolyard samples, ten of the eleven arsenic concentrations were below the MDL and the single reported value exhibited a relative percent difference of 42%; the arsenic values for this sample and its field duplicate were qualified as estimated. Ten of the eleven samples contained lead at less than five times the MDL and met the criteria of less than one MDL difference between the original field sample and its duplicate. One sample was subject to relative percent difference criteria for lead and met the criteria at 14%.

2.3.4 Variability Tests

Intra-sample variability tests were performed to verify that homogenization of the composite sample was sufficient to reduce variability, which ensures that the portion that is prepared and analyzed is representative of the composite (and therefore representative of the property). Variability tests involved collecting and separately preparing seven aliquots of the homogenized composite sample. Test were performed on ten samples. For concentrations that were greater than the MDL, all test samples exhibited a percent relative standard deviation of less than 25%.

2.4 <u>Comparability</u>

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Comparability was evaluated during Phase IIIA through preparation and analysis of confirmation soil samples.

2.4.1 Confirmation Samples

A percentage of the samples were split and prepared as confirmation samples. Initially, one confirmation sample was prepared for every three field samples, and after initial results were reviewed, the frequency was reduced to one in ten field samples. The confirmation samples were submitted to an off-site, fixed laboratory for analysis by EPA Method 6010B, Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP). Results for blind standards submitted along with the confirmation samples are presented in Figures 13 through 16.

A portion of the confirmation sample results were qualified as estimated based on the laboratory's quality control data. However, no major anomalies were identified and no data were rejected. The comparison of XRF versus ICP results are presented in Figure 17. The results exhibit a high degree of correlation, with the exception of two ICP lead concentrations reported greater than 1400 mg/kg. The correlation coefficient excluding these two outliers is 0.9. The confirmation sample data document that the XRF results are generally comparable to those from ICP analysis.

2.5 <u>Completeness</u>

Completeness is a measure of the percent of useable data generated as compared to the data required and collected. Surface soil samples were collected from 1550 residential properties, which is 100% of the properties for which yards were physically accessible, and 98% of the properties for which written consent for access was received. Useable data were produced for 100% of the samples collected. These achievements are consist with the project completeness goals of sampling 100% of properties granting access, and producing useable data for greater than 90% of the data generated.

3.0 DUST SAMPLE DATA QUALITY

Dust samples were collected from indoor flooring surfaces using a high volume vacuum sampler. Candidate homes were identified based on a stratified random analysis and resident consent for interior access. One composite dust sample per home was collected from each of 76 homes. Dust samples were prepared and analyzed at an off-site, fixed laboratory by ICP using EPA Method 6010B.

3.1 Precision

Matrix spike duplicates and laboratory control sample duplicates were analyzed to measure precision of dust sample analyses.

3.1.1 Matrix Spike Duplicates

Matrix spike duplicates were prepared and analyzed at the required frequency of one per batch. The relative percent difference between the original matrix spike sample and its duplicate ranged from 0% to 2% for arsenic and 1% to 3% for lead, which meets the criteria of less than 25% relative percent difference.

3.1.2 Laboratory Control Sample Duplicates

Laboratory control sample duplicates were prepared and analyzed at the required frequency of one per batch. The relative percent difference between the original laboratory control sample and its duplicate ranged from 0% to 1% for arsenic and 0% to 2% for lead, which meets the criteria of less than 25% relative percent difference.

3.2 Accuracy

The accuracy of the dust sample results was verified through the initial and continuing calibrations, matrix spike samples, laboratory control samples, interference check samples, and blind standards.

3.2.1 Instrument Calibration

Initial calibration verification demonstrates that the instrument is capable of acceptable performance at the beginning of the analytical run, while continuing calibration verification demonstrates that the initial calibration remains valid. Initial and continuing calibration verifications met the quality control criteria for percent recovery of 90-110% of the certified standard concentration, ranging from 97% to 103%. The initial calibration verifications were analyzed at the beginning of each analytical run. The continuing calibration verifications were analyzed every ten samples.

3.2.2 Matrix Spikes

Matrix spikes are prepared by adding a known concentration of one or more analytes to a field sample, and is designed to provide information about the effect of each sample matrix on the sample preparation procedures and the measurement methodology. All matrix spikes met the quality control criteria for percent recovery of 75-125%. Recoveries ranged from 97% to 102% for arsenic and 68% to 111% for lead (the 68% recovery did not result in data qualification because the spike concentration was less than four times the sample concentration). Matrix spikes were analyzed at a frequency of one per batch.

3.2.3 Laboratory Control Samples

The laboratory control sample serves as a monitor of the overall performance of each step during the analysis, including the sample preparation. Laboratory control samples were analyzed at the proper frequency and met the acceptance criteria for percent recovery of 80-120%, ranging from 100% to 104% for arsenic and 94% to 99% for lead.

3.2.4 Interference Check Samples

Interference check samples verify the laboratory's inter-element and background correction factors. The interference check sample was analyzed at the beginning and end of each analytical run. The percent recovery results were within the quality control limits of 80-120%, ranging from 96% to 103% for arsenic and 87% to 94% for lead.

3.2.5 Blind Standards

Four aliquots each of four samples were prepared and sent to two separate laboratories to determine the nominal concentration of each sample. The nominal concentration was determined by averaging the eight reported values for arsenic and for lead. Thirty blind standards were then submitted for analysis along with the field dust samples. The results of blind standards analyses are presented in Figures 18 and 19.

3.3 <u>Representativeness</u>

Representativeness of dust samples has been assessed through instrument blanks, method blanks, and rinse blanks.

3.3.1 Instrument and Method Blanks

None of the initial or continuing calibration blanks contained arsenic or lead above the reporting limit. The initial calibration blank was analyzed at the beginning of each analytical run and continuing calibration blanks were analyzed after every ten samples. One method blank was analyzed per batch. Method blanks also were free from contamination, indicating that laboratory contamination did not occur.

3.3.2 Rinse Blanks

Rinse blanks were collected at the specified frequency of 5% (one for every twenty field samples) by rinsing the interior surfaces of the decontaminated vacuum sampler that contact the dust sample with deionized water and containing the rinsate. The rinse blanks were free from contamination, which demonstrates that proper decontamination was performed to reduce the possibility of cross contamination.

3.4 <u>Completeness</u>

Completeness is expressed as the percent of usable data as compared to the data collected. Unuseable data are those results reported by the laboratory but rejected during the data validation process. Objectives for dust sampling included collecting between 60 and 90 samples. The desired quantity was achieved and 100% percent of the dust data are useable.

4.0 VEGETABLE SAMPLE DATA QUALITY

Properties where gardens had been documented and that still had vegetables available in October were sampled for vegetables prior to hard frost. A total of 72 vegetable samples were collected from 19 gardens. Vegetables were prepared and analyzed at an off-site, fixed laboratory by ICP-MS using EPA Method 6020.

4.1 <u>Precision</u>

Matrix spike duplicates were analyzed to measure precision of vegetable sample analyses.

4.1.1 Matrix Spike Duplicates

Matrix spike duplicates were prepared and analyzed at the required frequency of one per batch. The relative percent difference between the original matrix spike sample and its duplicate ranged from 1% to 5% for arsenic and 1% to 4% for lead, which meets the criteria of less than 25% relative percent difference.

4.2 <u>Accuracy</u>

The accuracy of the dust sample results was verified through the initial and continuing calibrations, matrix spike and post digestion spike recoveries, interference check samples, laboratory control samples, an MDL study, and blind standards.

4.2.1 Instrument Calibration

Initial and continuing calibration verifications met the quality control criteria for percent recovery of 90-110%, ranging from 97% to 103%. The initial calibration verifications were analyzed at the beginning of each analytical run. The continuing calibration verification was analyzed every ten samples.

4.2.2 Matrix Spikes

All matrix spikes and post digestion spikes met the quality control criteria for percent recovery of 75-125% and frequency criteria of one per batch, ranging from 103% to 112% for arsenic and 87% to 98% for lead.

4.2.3 Interference Check Samples

Interference check samples were analyzed at the beginning and end of each analytical run. The interference check sample percent recovery results were within the quality control limits of 80-120% at 99% to 101% for arsenic (lead was below the MDL).

4.2.4 Laboratory Control Samples

All laboratory control samples met the quality control criteria established for the standard reference materials used, ranging from 73% to 107% for arsenic and 88% to 98% for lead.

4.2.5 Method Detection Limit Study

Seven aliquots of one sample (NIST SRM 1570, spinach leaves) were prepared and analyzed individually. The SRM certified value for arsenic is 0.068 mg/kg (plus or minus 0.012 mg/kg) and the uncertified value for lead is 0.2 mg/kg. Results of seven analyses of the SRM exhibited a low standard deviation (less than 0.012) for both analytes, which documented that the targeted method detection limit of 0.05 mg/kg was achieved.

4.2.6 Blind Standards

NIST SRM 1570 was used to prepare blind standards submitted to the laboratory along with the vegetable samples. Measured concentrations ranged from 74% to 162% of the certified value for arsenic and were 80% of the non-certified value for lead. The SRM arsenic and lead concentrations are near the MDL and less than the PQL, and therefore reported values in this range are considered estimated.

4.3 Representativeness

Representativeness has been assessed through instrument blanks and method blanks.

4.3.1 Instrument and Method Blanks

None of the initial or continuing calibration blanks contained arsenic or lead above the reporting limit. The initial calibration blank was analyzed at the beginning of each analytical run and continuing calibration blanks were analyzed after every ten samples. The method blanks were analyzed at the correct frequency of one per batch. Method blanks also were free from contamination, indicating that laboratory contamination did not occur.

4.4 Completeness

No vegetable sample results were rejected upon validation of the data, and therefore 100% percent of the vegetable data are useable.

5.0 PROPERTY SOIL DISTRIBUTIONAL ANALYSIS

In the "Project Plan for the Vasquez Boulevard & I-70 Site, Denver Colorado, Phase III Field Investigation" (ISSI, 8/4/99), Appendix D "Screening Level Evaluation of Risks from Acute and Subchronic Exposure to Arsenic in Soil" sets forth a three-tiered decision rule that the sampling results from a residential property must pass in order for the property to be considered below acceptable risk levels. These are:

1) 95% upper confidence limit (UCL) of three composites ≤ RBCchronic
2) Maximum composite value ≤ MTCVacute
3) Maximum composite value ≤ MTCVsubchronic

A key assumption for test number one is that the data are normally distributed. Whereas statistical tests (USEPA, DataQuest software) are available to determine whether sample data can be considered normally distributed, it is difficult to determine accurately whether three individual samples are in fact normally distributed. Given this, the field sampling program used a composite sampling design. The composite design was implemented in an attempt to ensure normal data from each residential property.

Monte Carlo simulations were run to determine an economically reasonable and scientifically reliable number of samples that should be combined into a single composite sample (ISSI, 8/4/99). As a result of the simulation exercise, it was decided that ten samples would be combined to form a composite sample.

One of the early steps in the Data Quality Assessment process is to determine if sample data can be considered normal so that a UCL on the mean can be calculated using normal statistics. Traditional quantitative tests for normality are not appropriate due to a paucity of data; therefore, other qualitative evaluations were performed to assess the assumption of normality.

If the field data from the sampled residential properties are to be considered normal, they should exhibit certain statistical characteristics. Among these include:

1) The coefficient of variation (CV) for the sample data generally should be in the range of the test data;
2) The CV should be below 1.0; and,
3) The maximum concentration observed at a residential property should not exceed the mean plus two standard deviations at more than 5% of the properties.

To test statistical characteristic number one, the CVs from 901 properties were calculated and compared to the CVs in the simulated data, which ranged from 0.16 to 0.37 with associated means ranging from approximately 50 mg/kg to 500 mg/kg. The CVs from the sampled properties with sample concentrations above the method detection limit generally fell within this range.

For statistical characteristic number two, if a CV exceeds 1.0, the data are generally considered to be non-normally distributed (USEPA 1996, Guidance for Data Quality Assessment, QA/G-9). A total of 25 residential properties exhibited CVs in excess of 1.0. This is approximately less than 2% of the residential properties and is attributable to concentrations either near the MDL or relatively high as compared to the proposed risk-based action levels.

To test statistical characteristic number three, the maximum concentration at each residential property was compared to the mean plus two standard deviations. No maximum sample concentration at any of the 901 residential properties examined exceeded the mean plus two standard deviations. This provides an indication that the data from the residential properties do not violate the normality assumption.

In summary, the statistical characteristics of the sample data collected from the residential properties provide strong evidence that the sample data are normally distributed. Exceptions are restricted to very low and high concentrations, which should not impair decision making with regard to risk management.

Table 1

PHASE IIIA SOIL SAMPLING ANALYTICAL PROGRAM SUMMARY

SAMPLE TYPE	TOTAL
Field Samples	5207
Blind Duplicates	254
Lab Duplicates	264
Blind Standards	90
Lab Control Sample (SRM)	961
Instrument Blanks	415
Method Blanks	90
MDL Study Samples	27
Proficiency Samples	92
Variability Test Samples	72
Other Test Samples	118
Off-Site Confirmation Samples	751
TOTAL SAMPLES	**8341**

Figure 1
Laboratory Duplicate Results - Arsenic

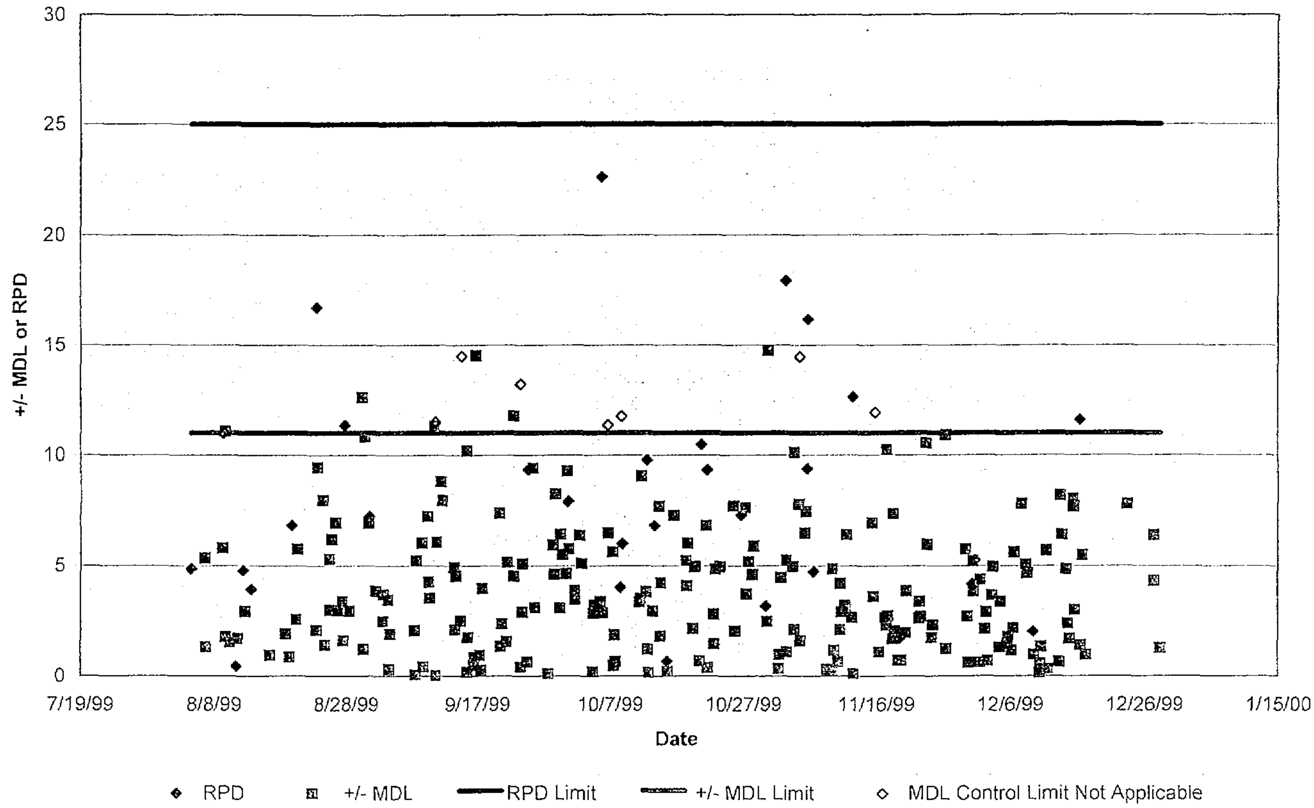


Figure 2
Laboratory Duplicate Results - Lead

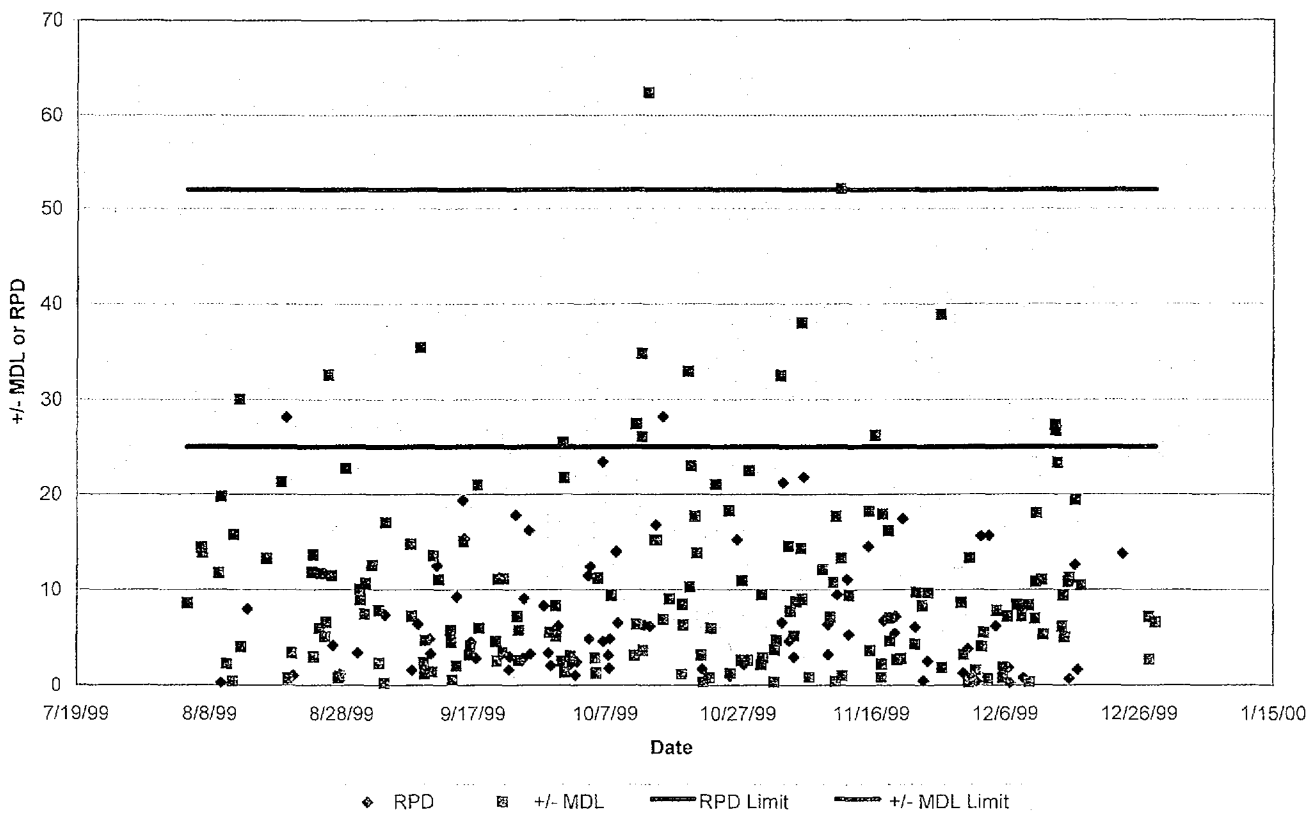


Figure 3
Laboratory Duplicate Correlation - Arsenic

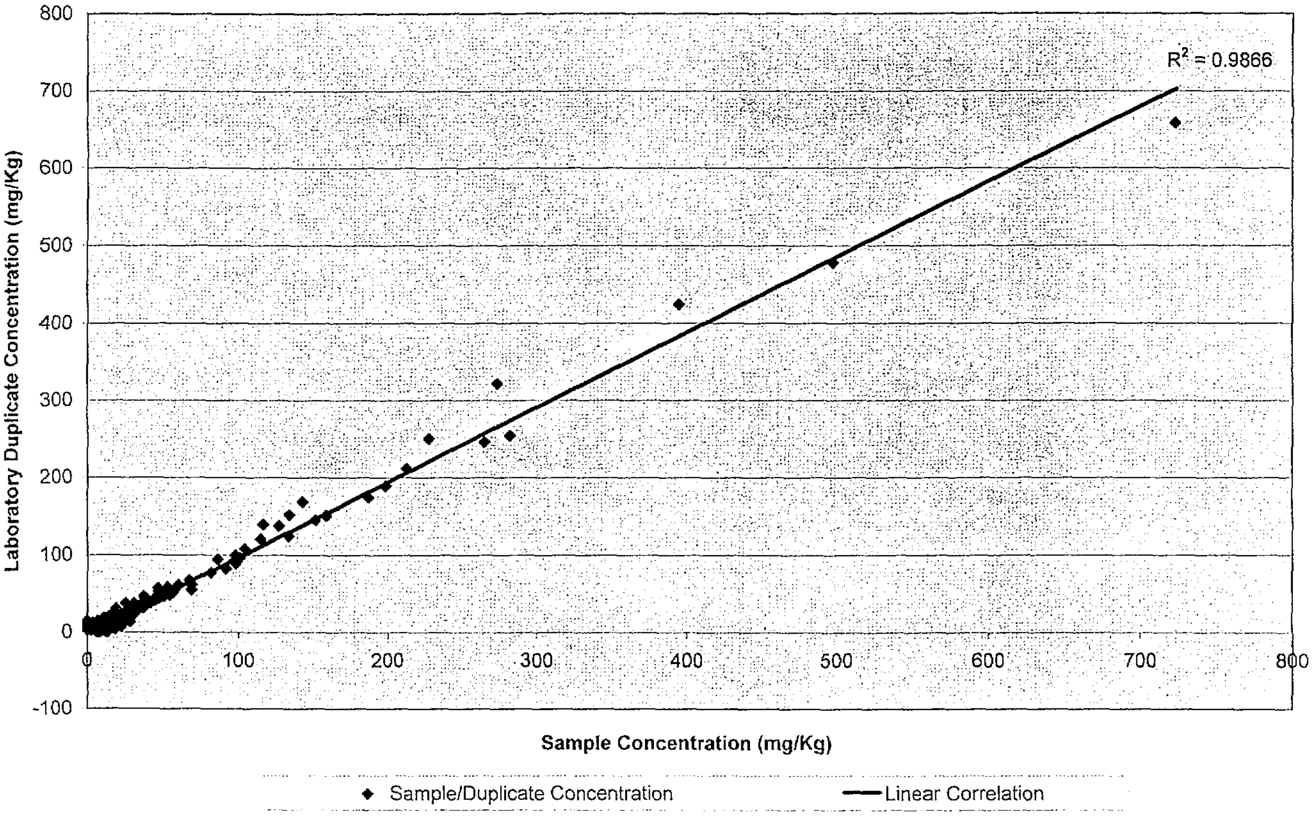


Figure 4
Laboratory Duplicate Correlation - Lead

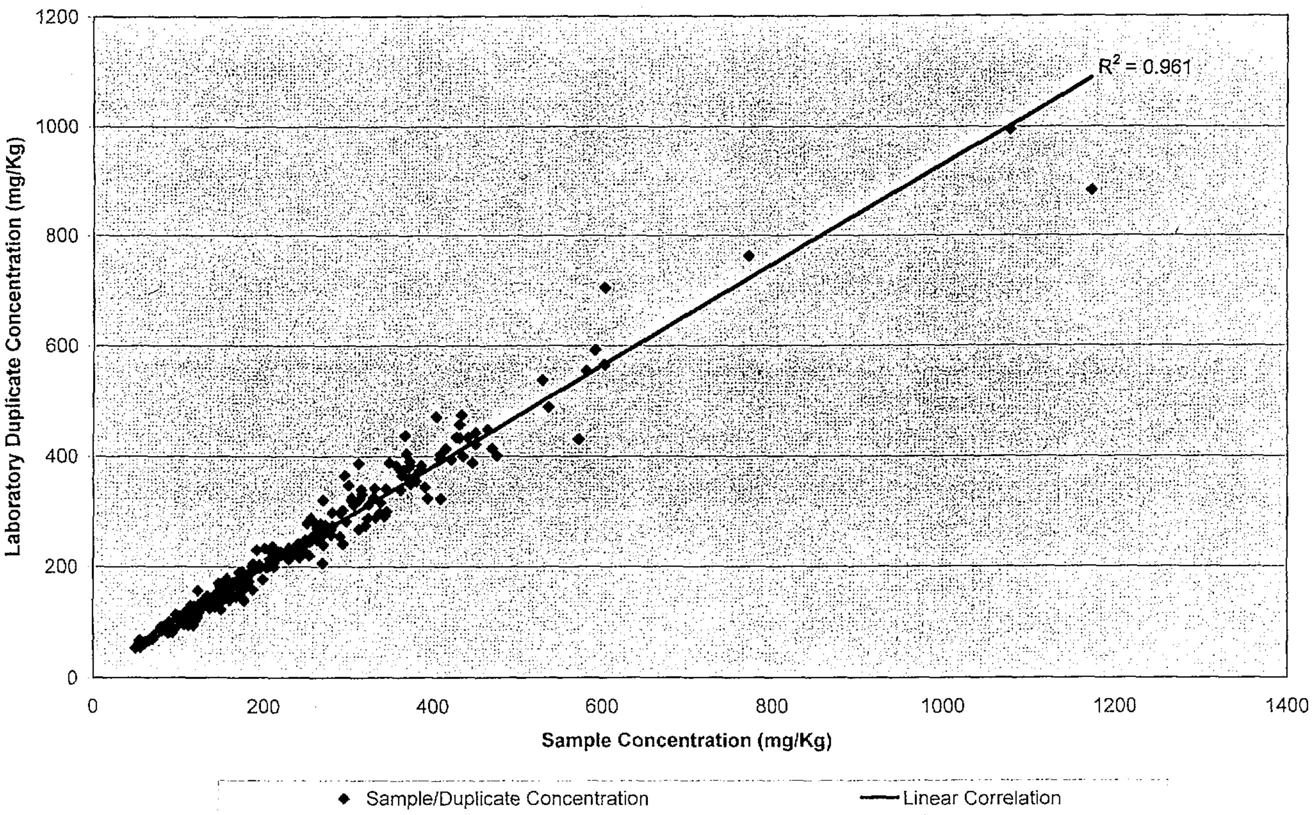


Figure 5
Blind Split Results - Arsenic

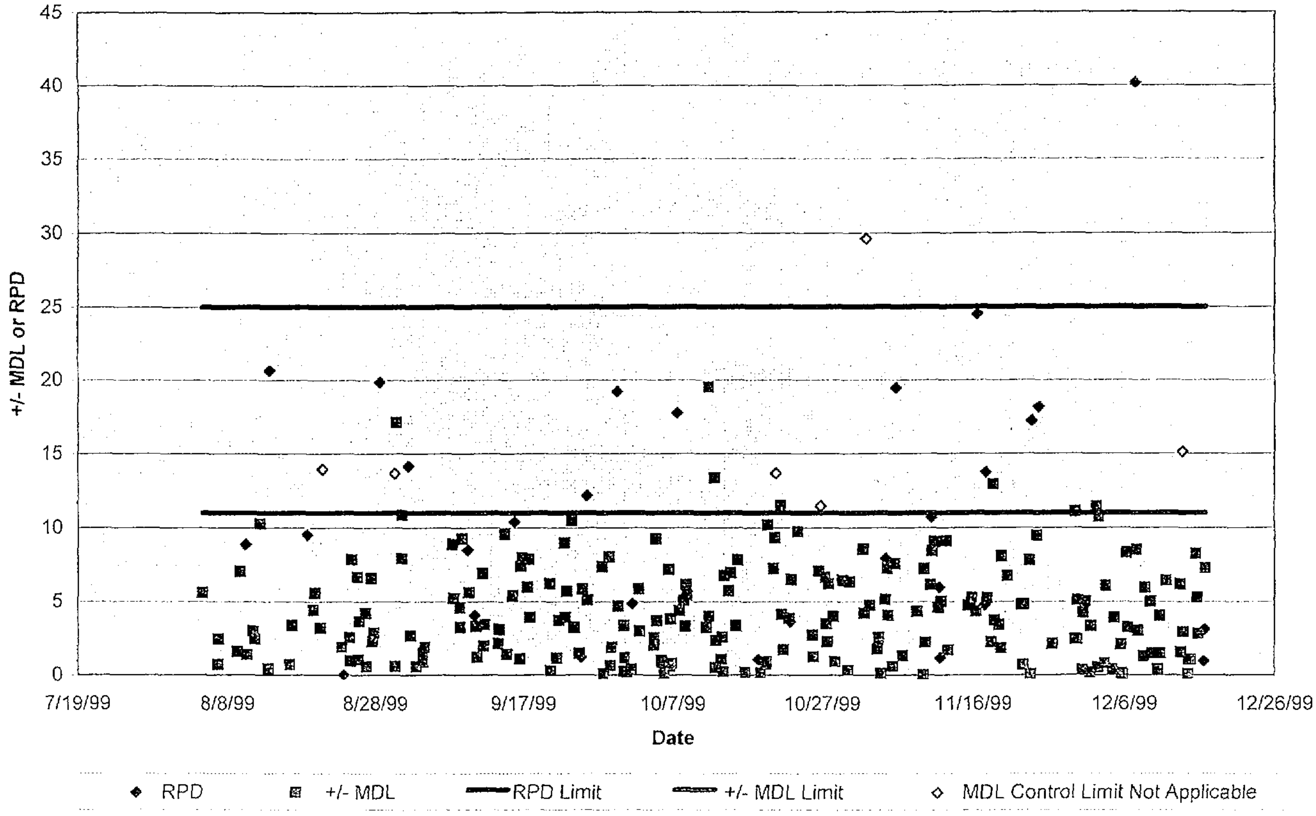


Figure 6
Blind Split Results - Lead

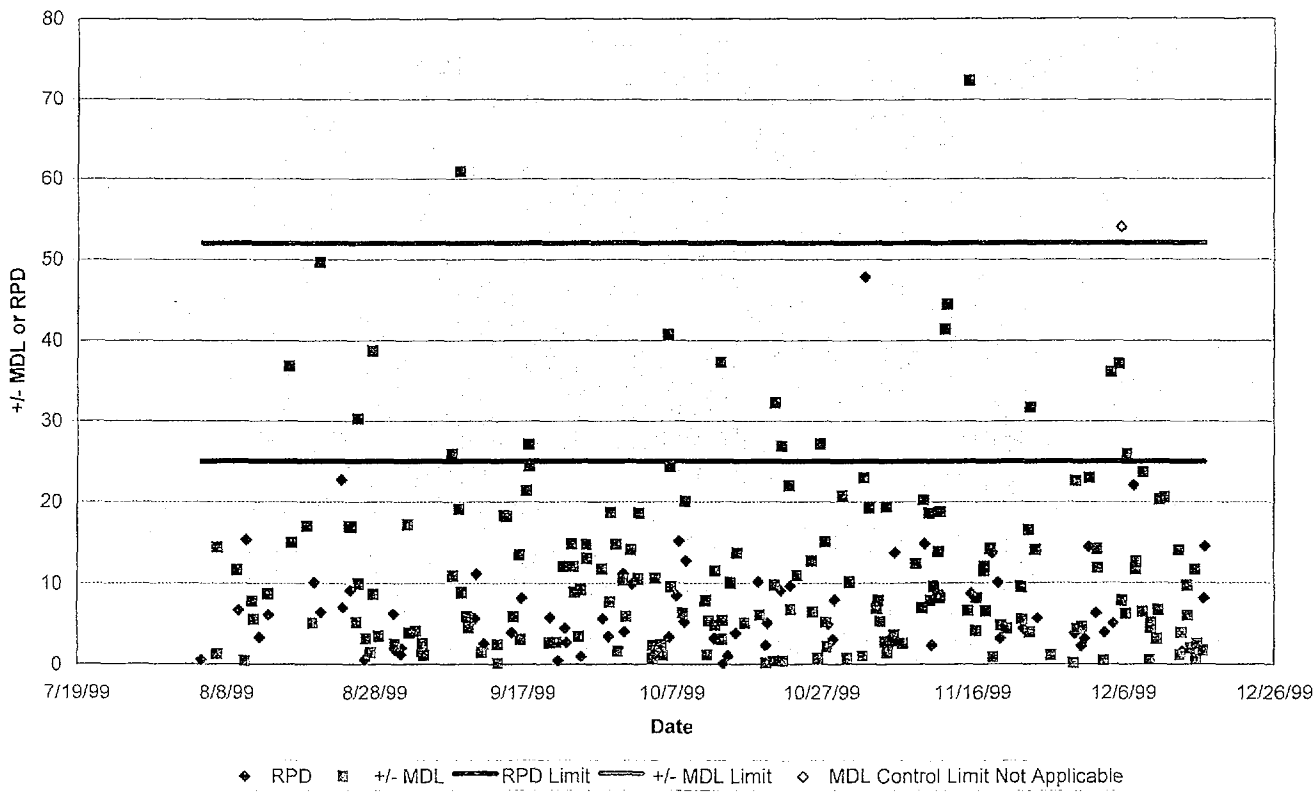


Figure 7
Blind Split Correlation - Arsenic

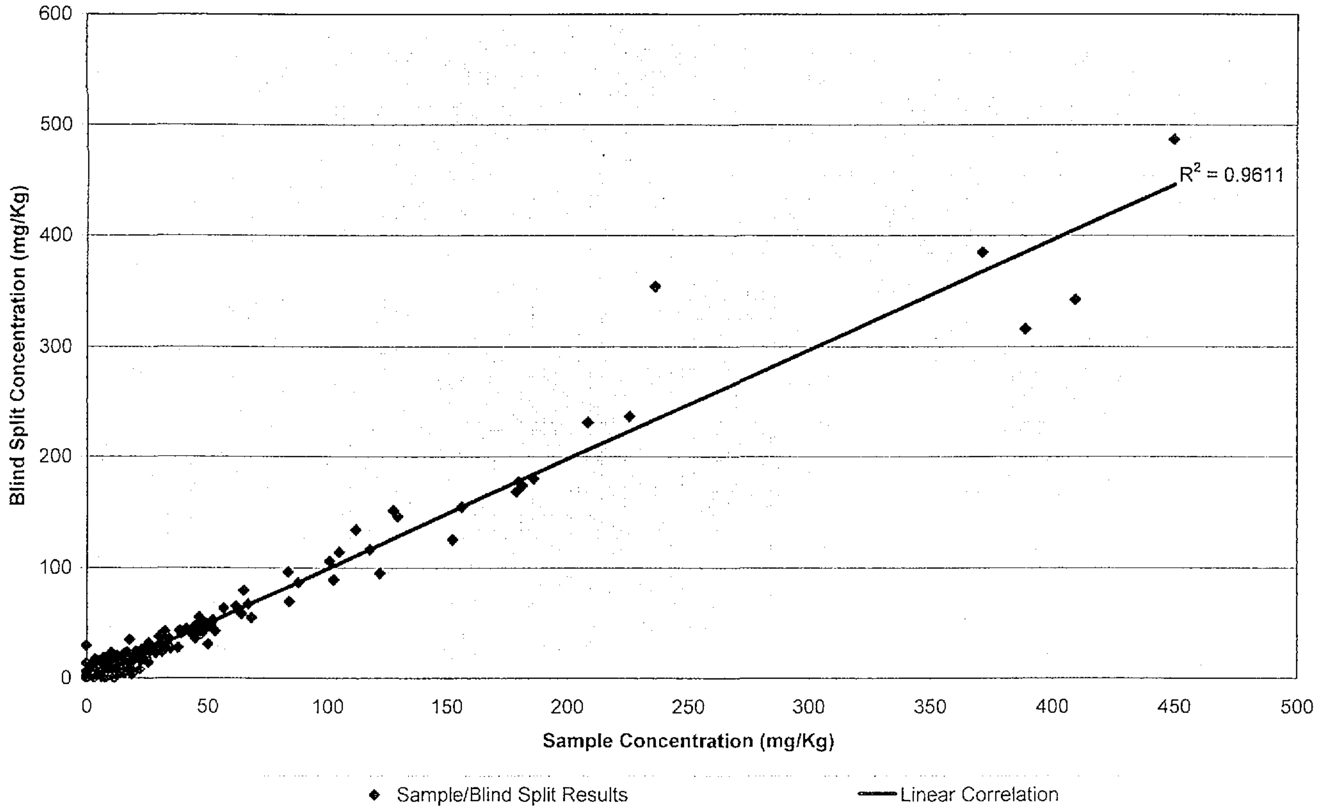


Figure 8
Blind Split Correlation - Lead

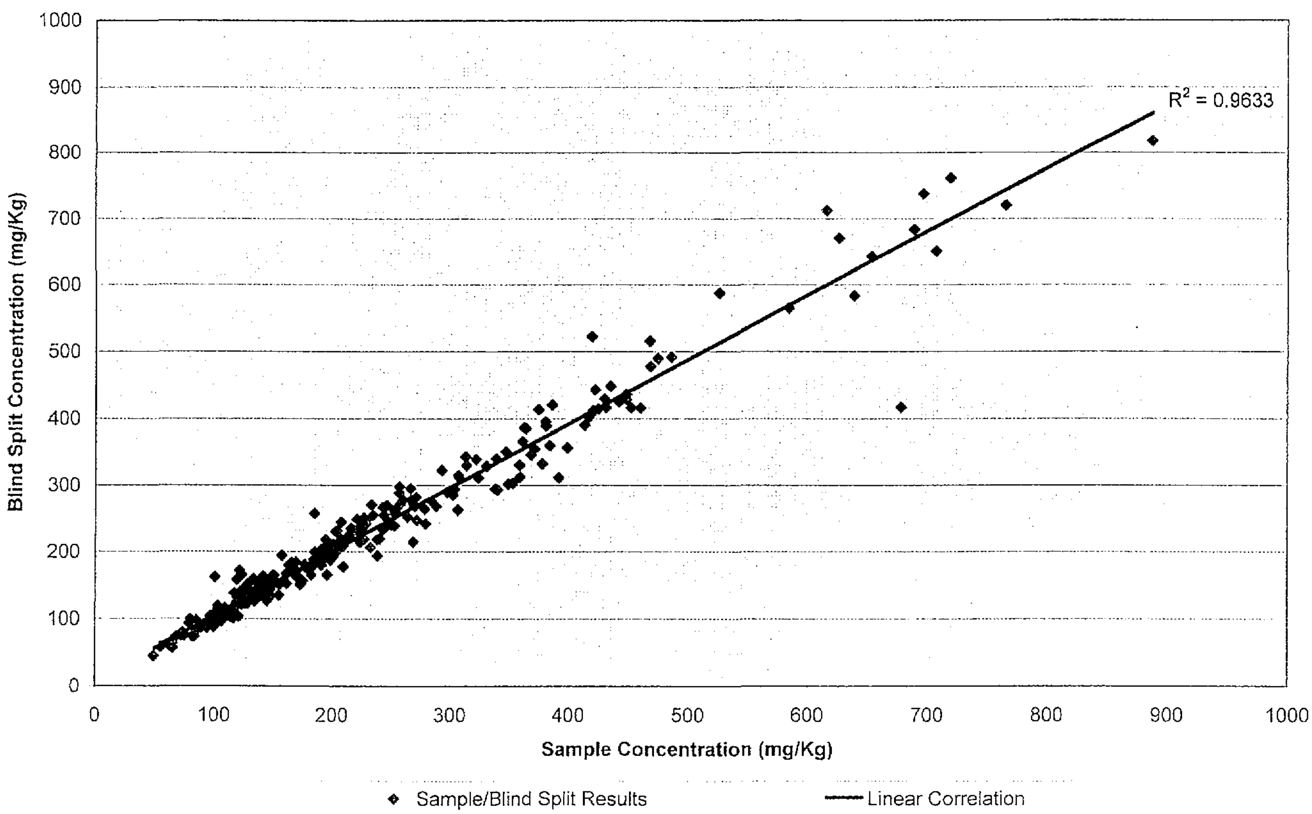
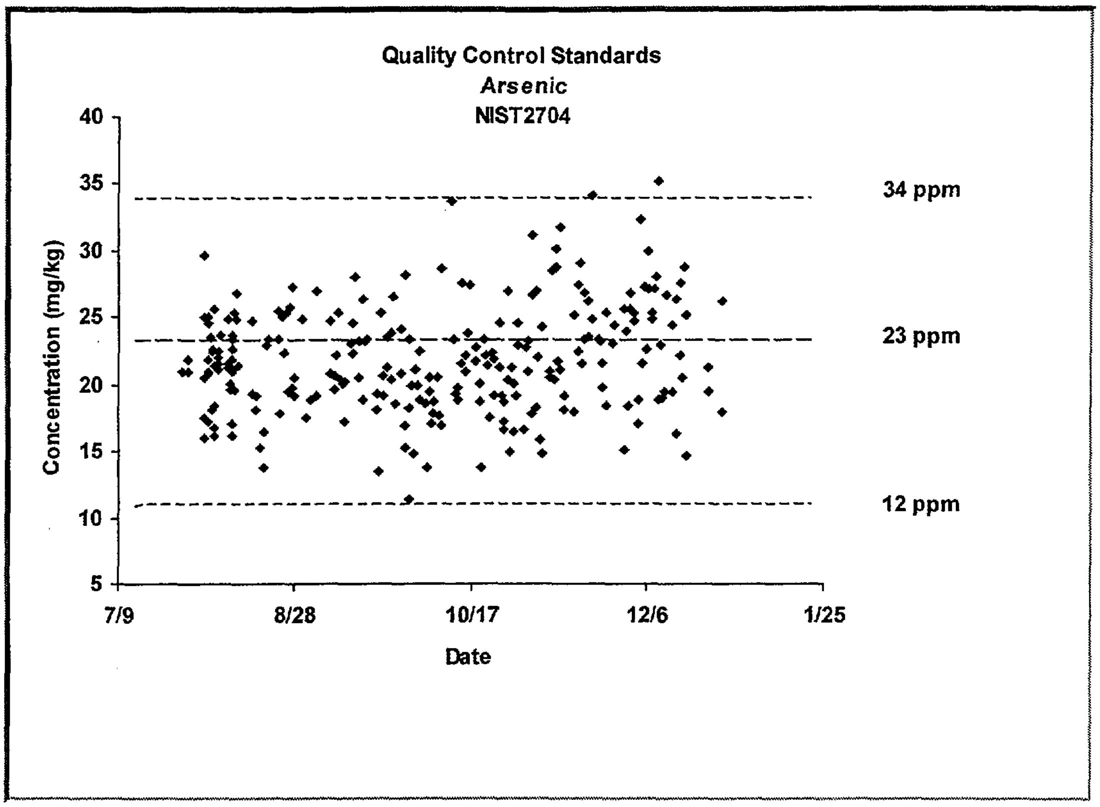
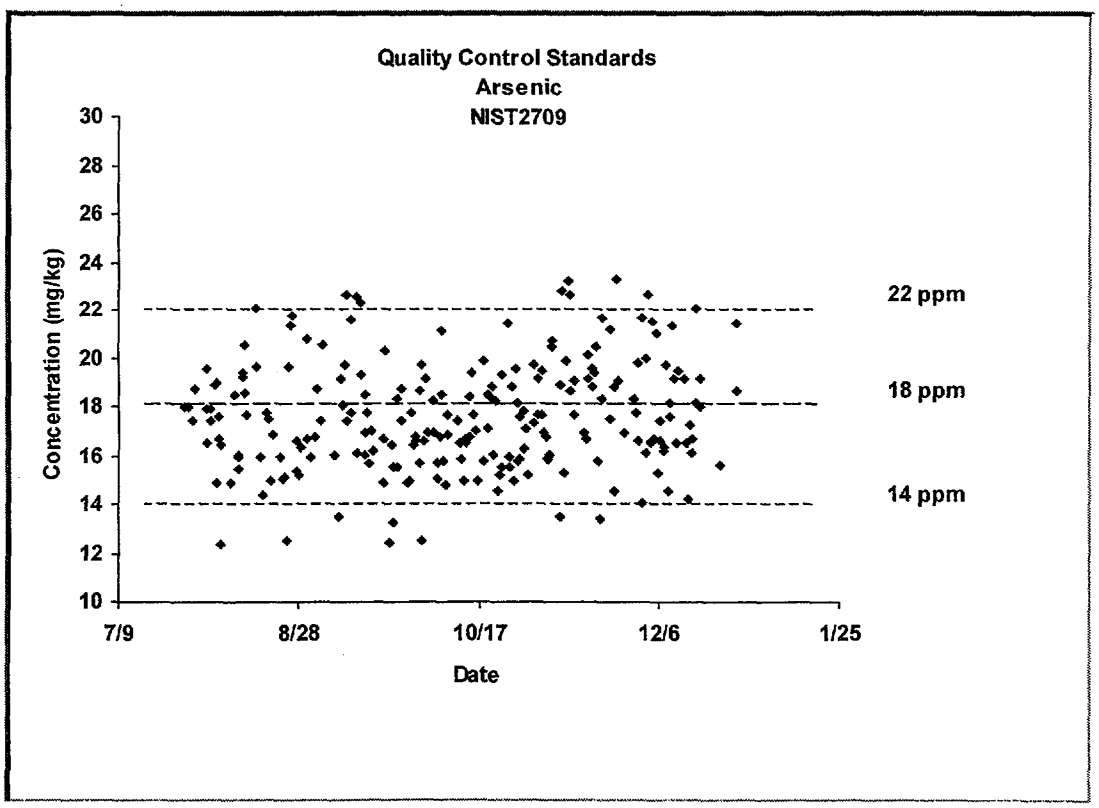


Figure 9

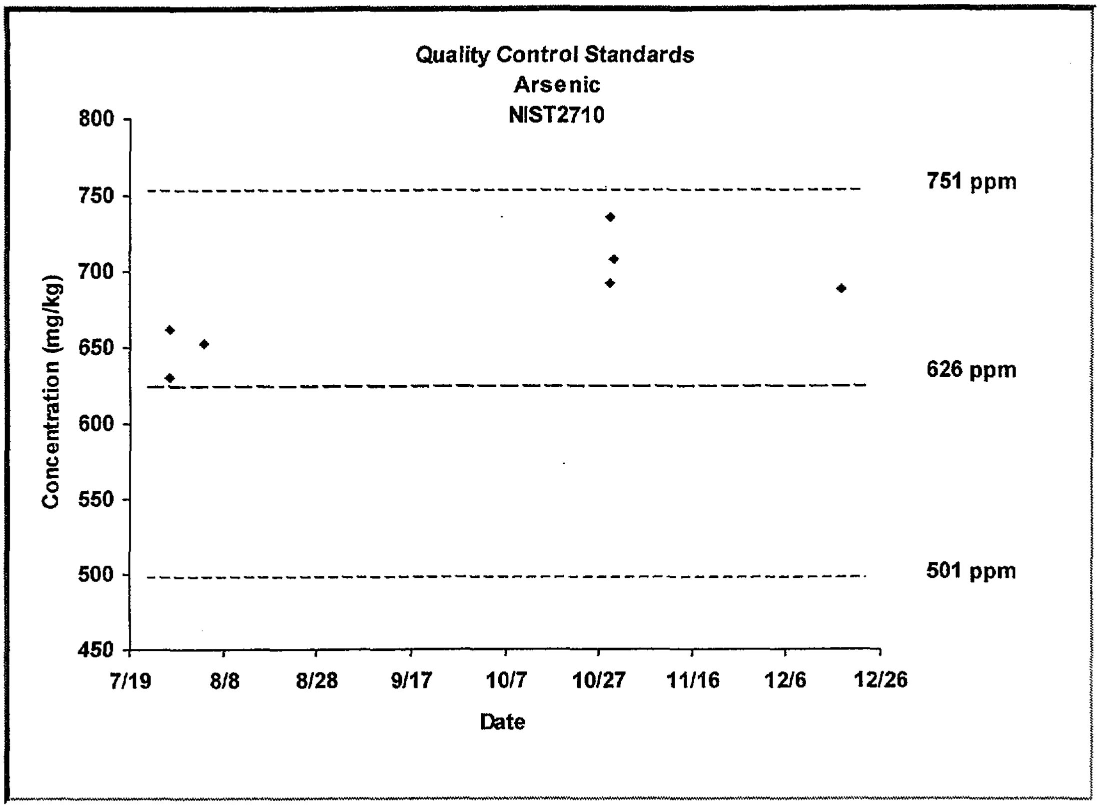


Quality Control Standards
Arsenic
NIST2704
Concentration (mg/kg)
40
35
30
25
20
15
10
5
34 ppm
23 ppm
12 ppm
7/9
8/28
10/17
12/6
1/25
Date



Quality Control Standards
Arsenic
NIST2709
Concentration (mg/kg)
30
28
26
24
22
20
18
16
14
12
10
22 ppm
18 ppm
14 ppm
7/9
8/28
10/17
12/6
1/25
Date

Figure 10


Quality Control Standards
Arsenic
NIST2710
Concentration (mg/kg)
800
750
700
650
600
550
500
450
751 ppm
626 ppm
501 ppm
7/19
8/8
8/28
9/17
10/7
10/27
11/16
12/6
12/26
Date

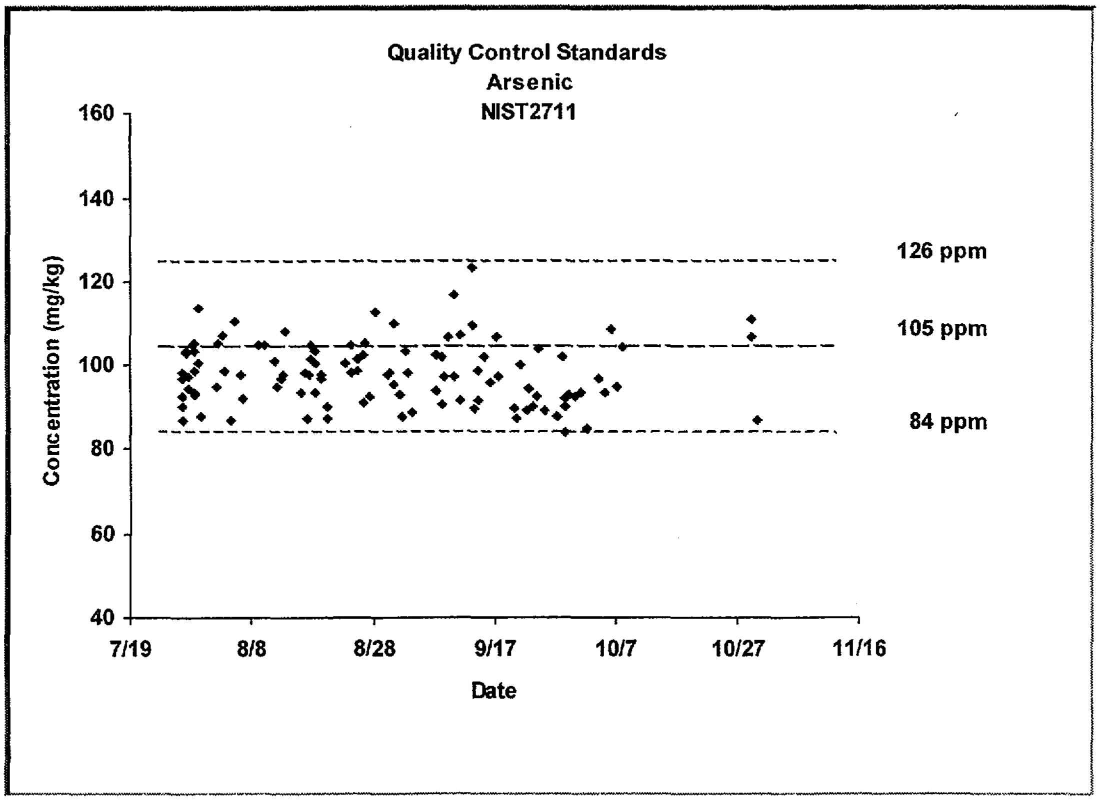
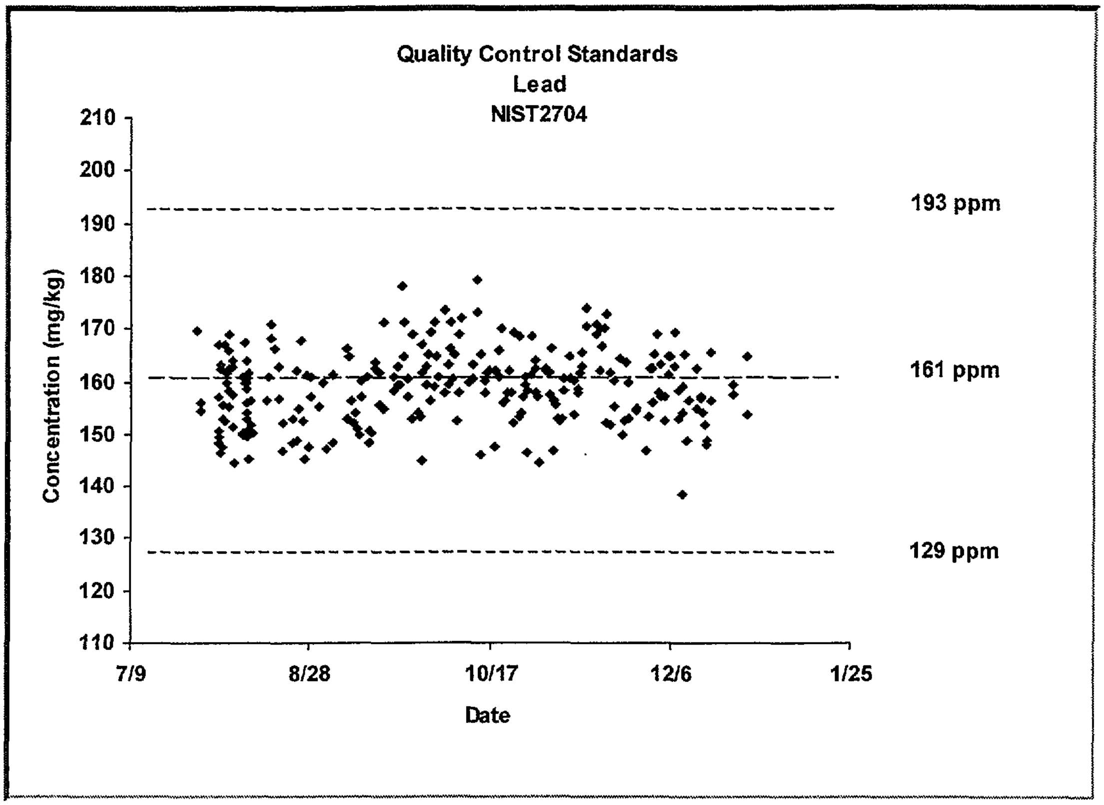
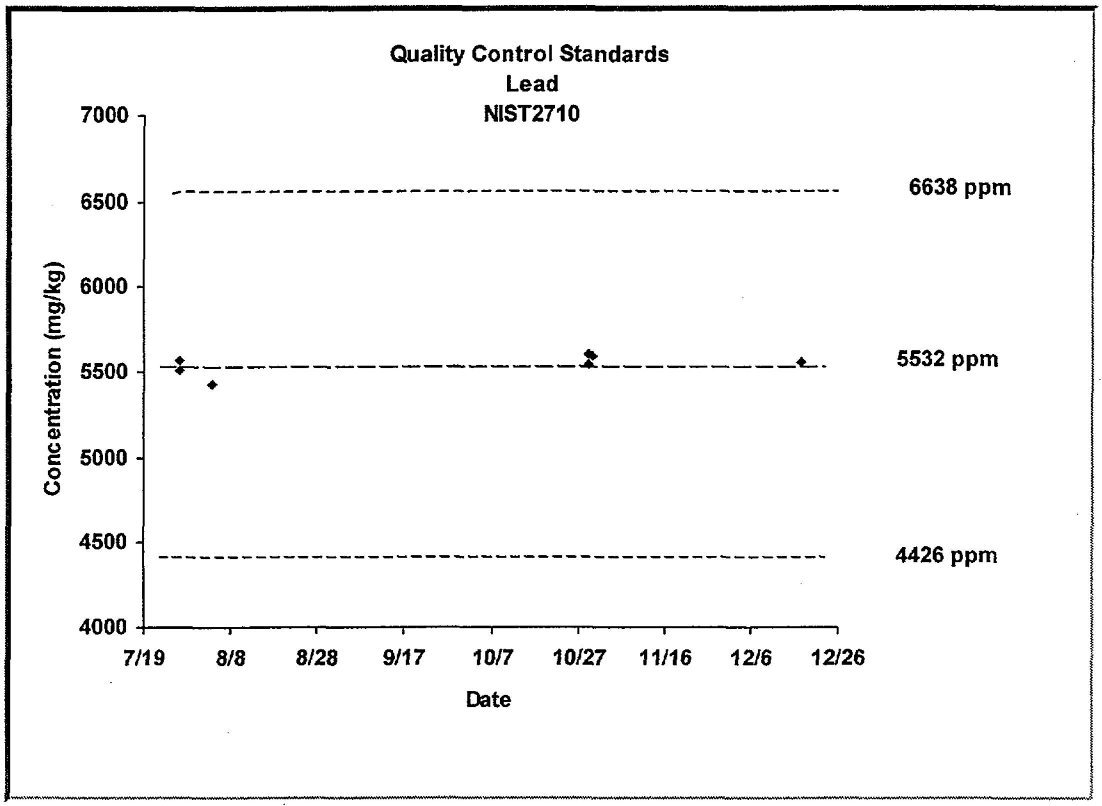

Quality Control Standards
Arsenic
NIST2711
Concentration (mg/kg)
160
140
120
100
80
60
40
126 ppm
105 ppm
84 ppm
7/19
8/8
8/28
9/17
10/7
10/27
11/16
Date

Figure 11



Quality Control Standards
Lead
NIST2704
Concentration (mg/kg)
210
200
190
180
170
160
150
140
130
120
110
193 ppm
161 ppm
129 ppm
7/9
8/28
10/17
12/6
1/25
Date

Figure 12


Quality Control Standards
Lead
NIST2710
Concentration (mg/kg)
7000
6500
6000
5500
5000
4500
4000
6638 ppm
5532 ppm
4426 ppm
7/19
8/8
8/28
9/17
10/7
10/27
11/16
12/6
12/26
Date

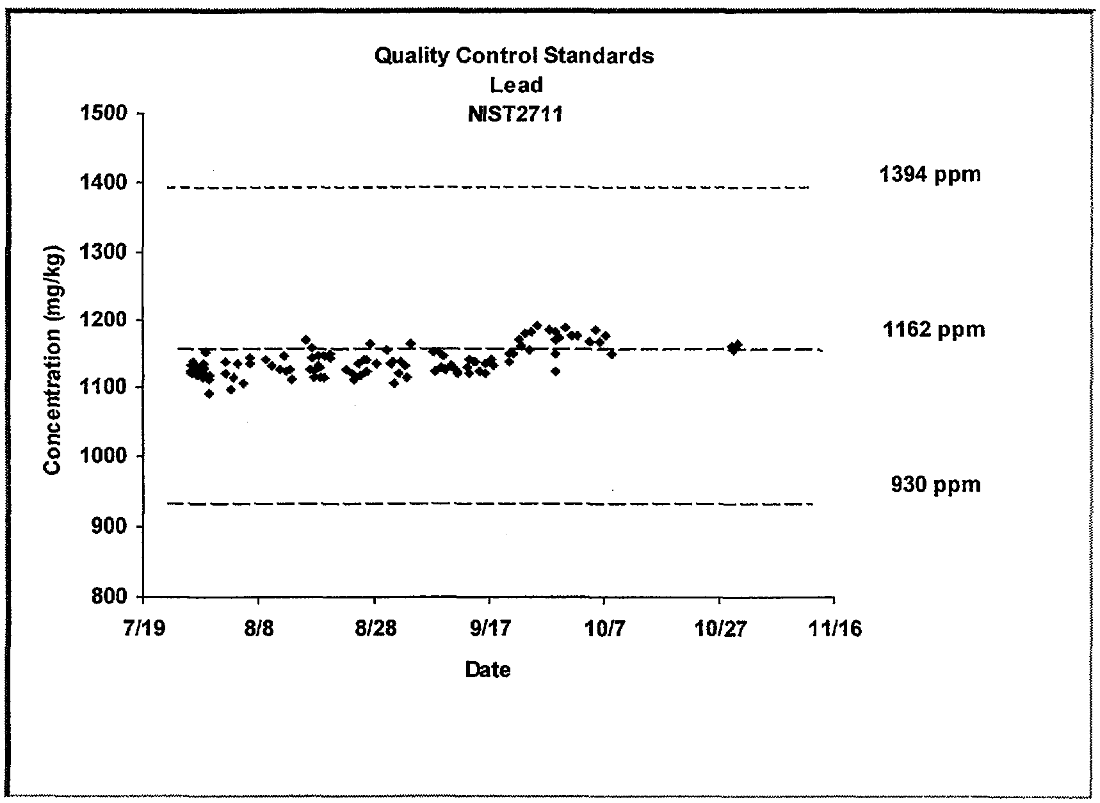

Quality Control Standards
Lead
NIST2711
Concentration (mg/kg)
1500
1400
1300
1200
1100
1000
900
800
1394 ppm
1162 ppm
930 ppm
7/19
8/8
8/28
9/17
10/7
10/27
11/16
Date

Figure 13
Blind Standards A, B, C, and D - Arsenic

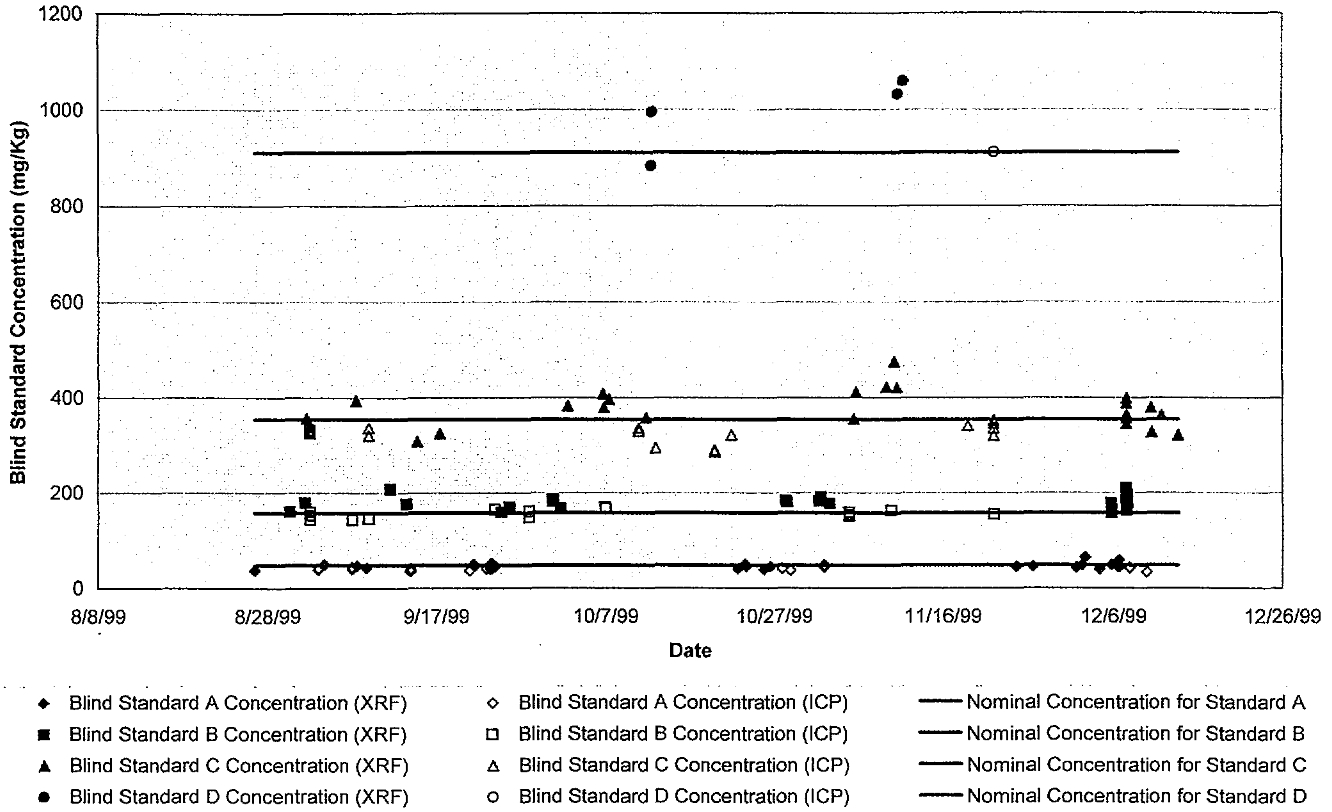


Figure 14
Blind Standards E and F - Arsenic

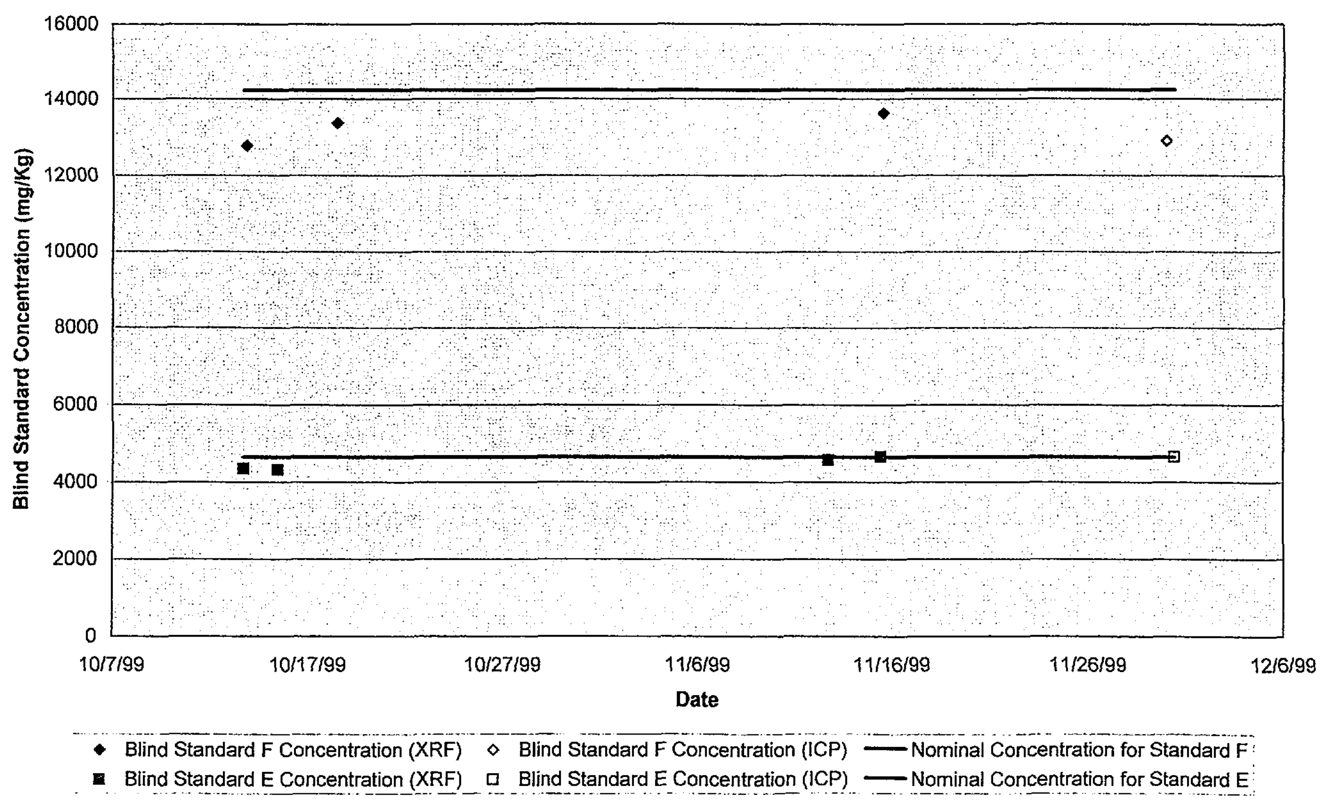


Figure 15
Blind Standards A, B, C, and D - Lead

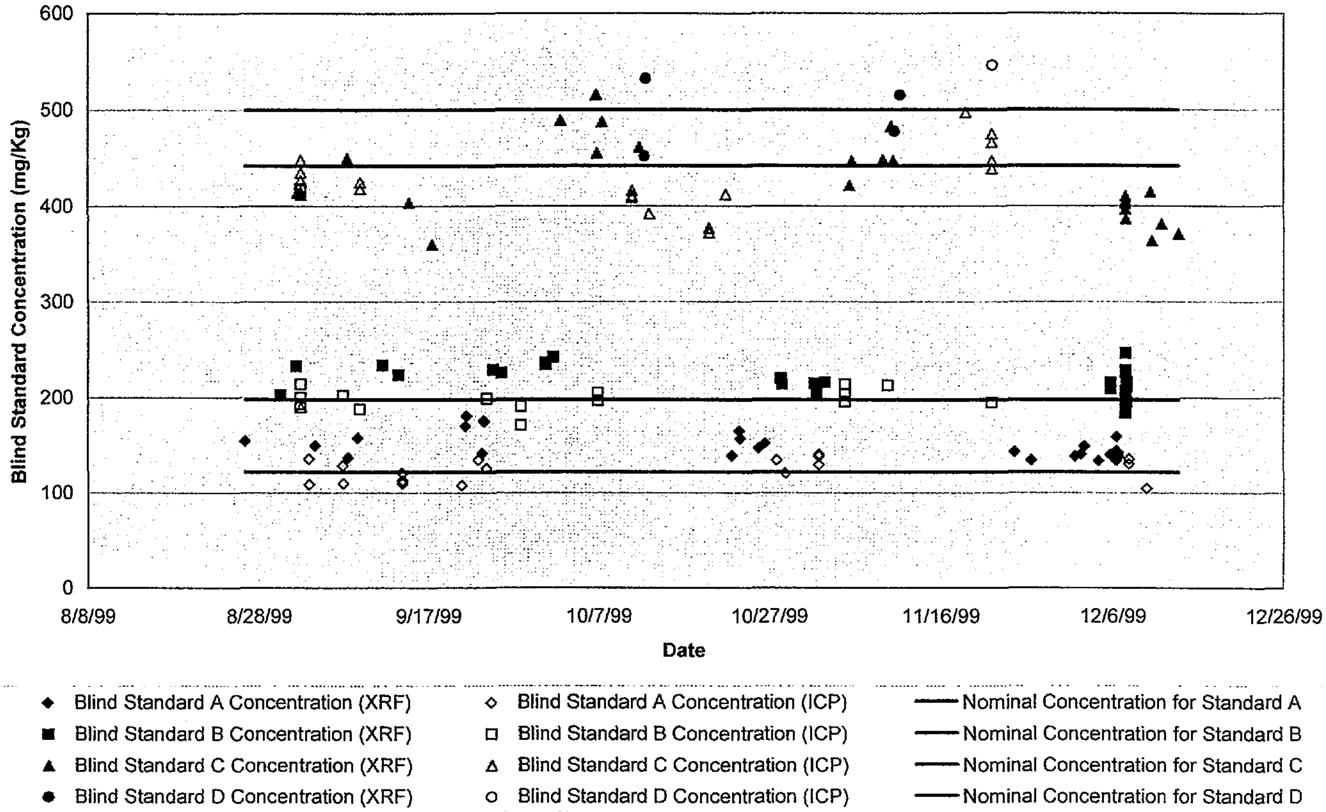


Figure 16
Blind Standards E and F - Lead

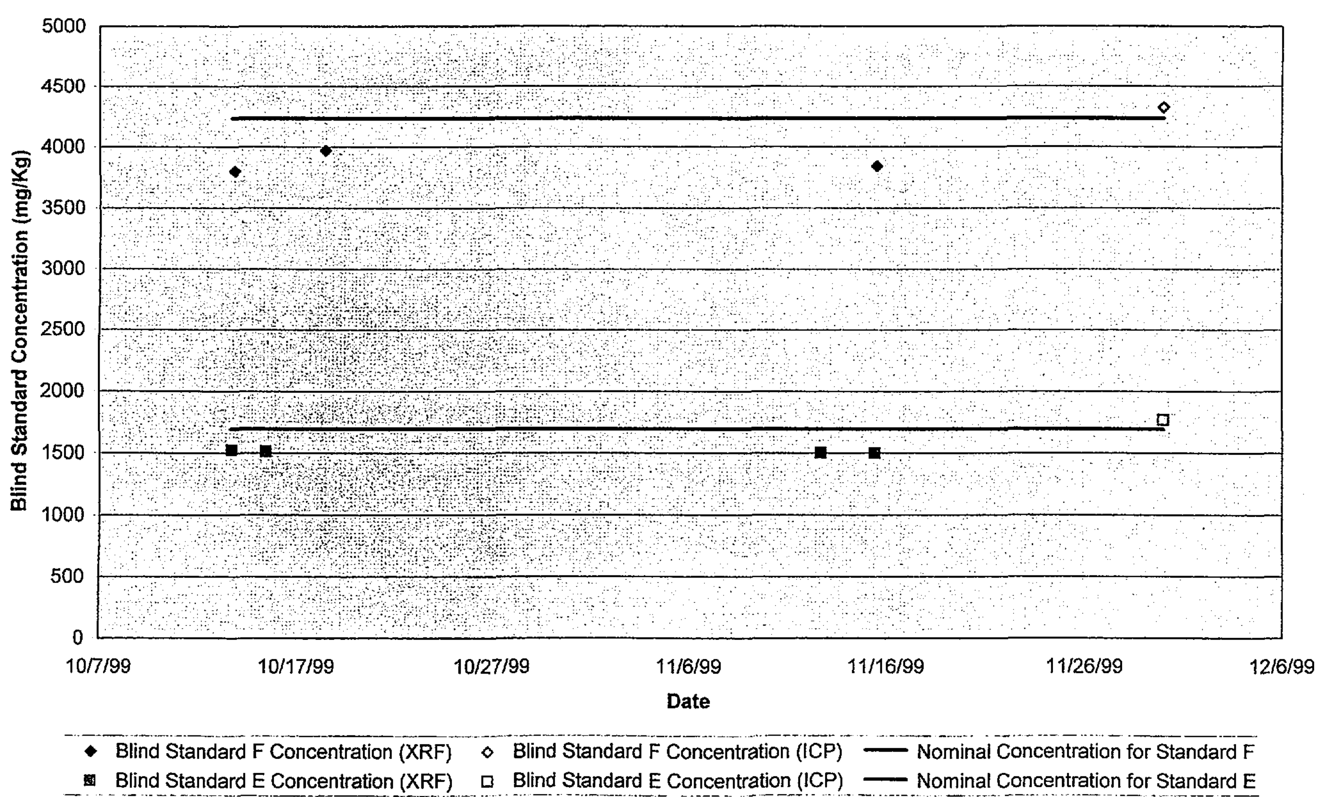
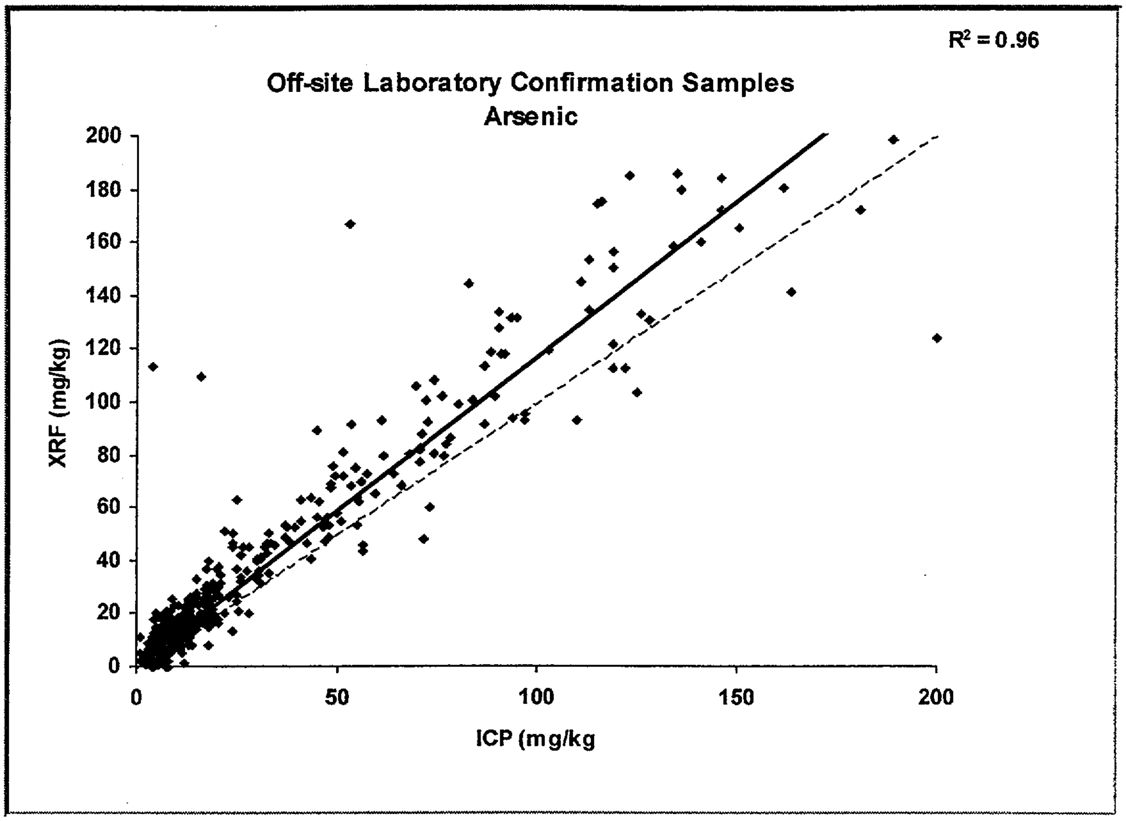
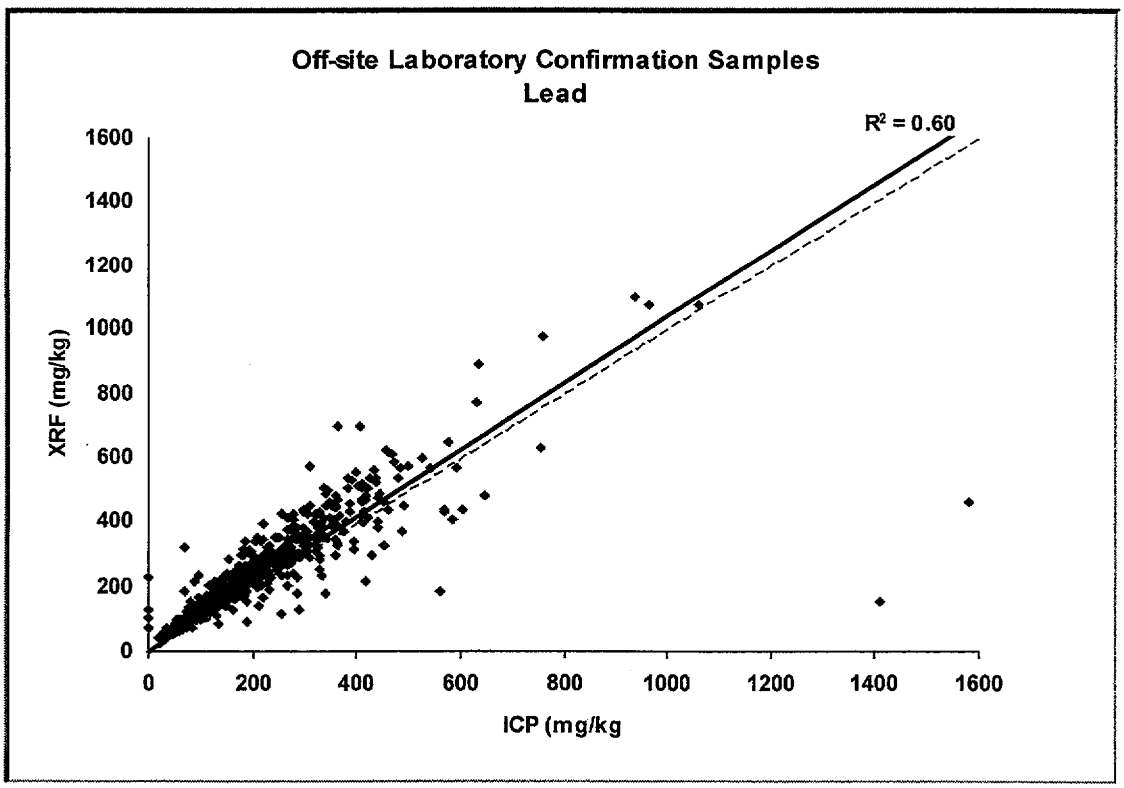


Figure 17



R² = 0.96
Off-site Laboratory Confirmation Samples
Arsenic
XRF (mg/kg)
0
20
40
60
80
100
120
140
160
180
200
0
50
100
150
200
ICP (mg/kg



Off-site Laboratory Confirmation Samples
Lead
R² = 0.60
XRF (mg/kg)
0
200
400
600
800
1000
1200
1400
1600
0
200
400
600
800
1000
1200
1400
1600
ICP (mg/kg

Figure 18

Dust Blind Standard A, B, C, and D - Arsenic

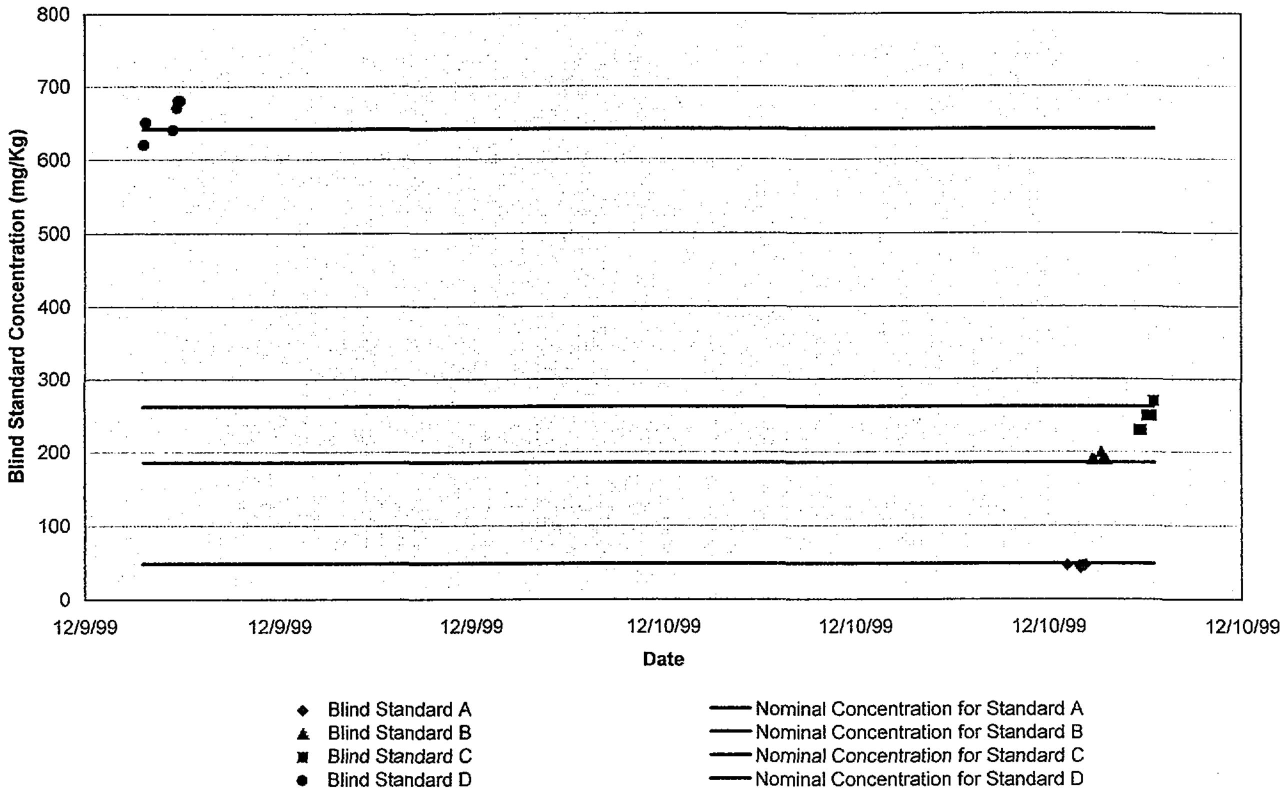
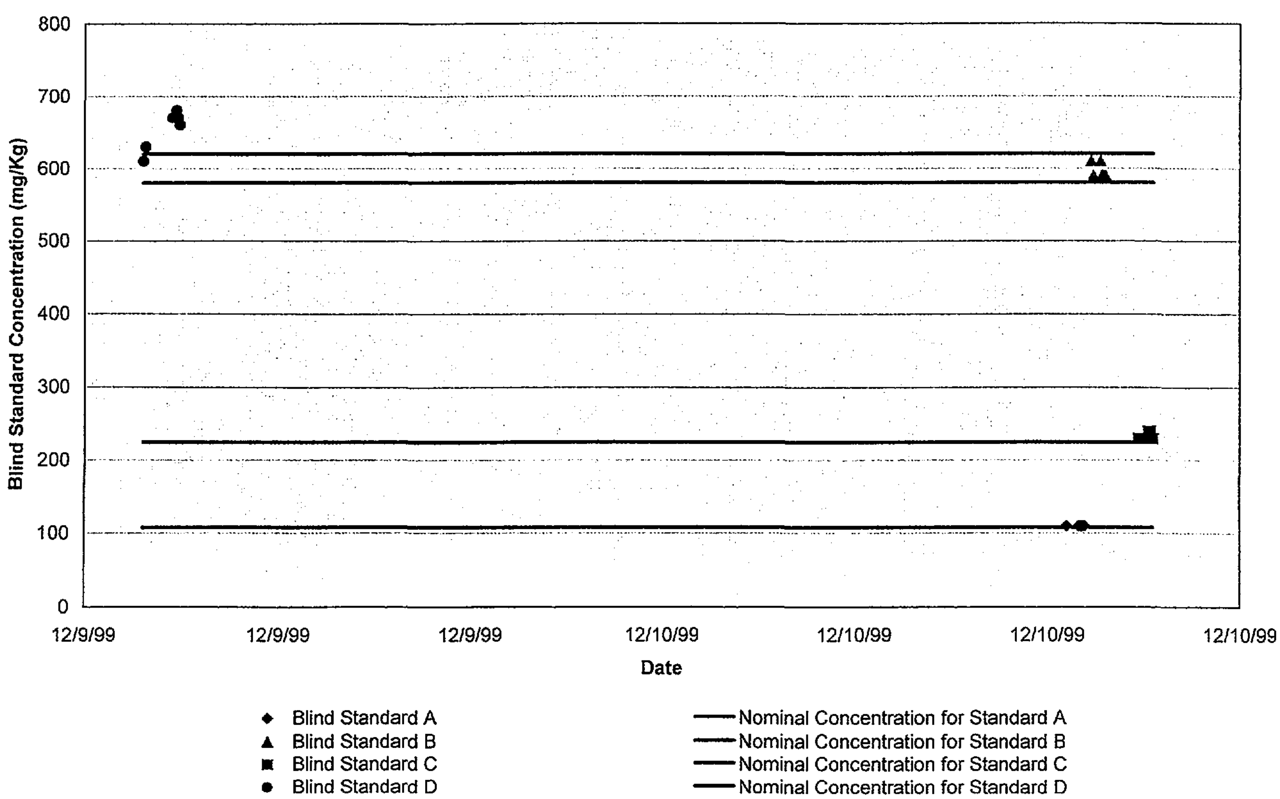


Figure 19

Dust Blind Standard A, B, C, and D - Lead



APPENDIX A5

Data Quality Assessment
Phase IIIB Sampling Program

DATA QUALITY ASSESSMENT
PHASE IIIB SAMPLING PROGRAM

VASQUEZ BOULEVARD AND I-70 REMEDIAL INVESTIGATION

November 21, 2000

Prepared for

U.S. Environmental Protection Agency
Region VIII

Washington
Federal Projects Division

Washington Group International, Inc.
10822 West Toller Drive
Littleton, Colorado 80127

Response Action Contract No. 68-W7-0039
Work Assignment 004-RICO-089R

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1.0 OVERVIEW

Chemical analysis of the Vasquez Boulevard/Interstate 70 (VB/I-70) Phase IIIB site characterization samples was conducted under a comprehensive quality assurance program. The program included requirements for the collection, preparation, and analysis of quality control samples, as specified in the Project Plan for the Vasquez Boulevard & I-70 Site, Phase III Field Investigation (ISSI, 08/04/99), Section 4.0 Quality Assurance Project Plan (QAPP), and related Standard Operating Procedures for sample collection, preparation and analysis.

An assessment of the data quality was performed daily throughout the program to verify compliance with the quality control criteria and to identify necessary corrective actions. An assessment of the Phase IIIB residential surface soil data has been performed to verify that the data set is consistent with and meets the data quality objectives identified in the QAPP. The data quality assessment is presented in terms of the precision, accuracy, representativeness, comparability, and completeness of the data. The results document that the data are usable for their intended purpose of identifying average surface soil concentrations and supporting the Baseline Risk Assessment.

2.0 SOIL SAMPLE DATA QUALITY

Soil samples were collected from residential yards, four schools, and six parks. All soil samples were prepared in the field laboratory by homogenizing the sample, drying a portion of the sample, sieving the sample through a #10 sieve, and then grinding a portion of the sieved, bulk fraction. The ground sample was analyzed at the field laboratory using a QuanX Energy Dispersive X-Ray Fluorescence Spectrometer (XRF). A percentage of samples were split and also submitted for off-site laboratory analysis.

Quality control sample results for soils analyzed by XRF are charted in Figures 1 through 17. Table 1 summarizes the number of soil field samples and each type of quality control sample.

2.1 <u>Precision</u>

Precision measures the reproducibility of values under a given set of conditions. Precision was measured in Phase IIIB soils through preparation and analysis of laboratory duplicates and blind split samples.

2.1.1 Laboratory Duplicates

Laboratory duplicates were prepared and analyzed at a frequency of one for every twenty field samples. Laboratory duplicates were identifiable to the analyst so that the duplicate and original field sample results could be reviewed immediately following analysis. The results of the laboratory duplicates are presented in Figures 1 through 4. Duplicates met the quality control criteria of less than 25% relative percent difference between the original sample and its duplicate, or less than one method detection limit (MDL) for samples with concentrations less than five times the MDL, in all but seven samples for arsenic and three samples for lead. The results for samples associated with the preparation of these ten duplicates exceeding the precision criteria were qualified as estimated. Overall correlation of original samples versus duplicates was very good.

2.1.2 Blind Splits

Blind split samples were prepared at the same frequency and in the same manner as laboratory duplicates, but were assigned a unique sample identification number and submitted blind to the analyst such that it could not be distinguished from other field samples. The results of the blind splits are presented in Figures 5 through 8. Blind splits met the quality control criteria of less than 25% relative percent difference between the original sample and its split, or less than one MDL for samples with concentrations less than five times the MDL, in all but thirteen samples for arsenic and five samples for lead. The results for samples associated with the preparation of these eighteen blind splits exceeding the precision criteria were qualified as estimated. Overall correlation of original samples versus blind splits was very good.

2.2 <u>Accuracy</u>

Accuracy measures the bias from the true value in a measurement system. Analytical accuracy was evaluated in soils through determination of the arsenic and lead MDLs, instrument calibration using certified standard reference materials (SRM), and analysis of blind standards.

2.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic or condition, and is achieved through proper design of a sampling program. Representativeness of soil samples has been assessed through preparation and analysis of blanks, comparison of field duplicates, and intra-sample variability tests.

2.3.1 Instrument and Method Blanks

Instrument blanks (Figure 19) consisting of clean sand were run with each analytical batch. Method blanks (Figure 20) consisted of clean sand that was processed through the entire laboratory preparation and analytical procedures on a daily basis. Instrument and method blank results all were below the MDLs and demonstrate that cross contamination did not occur between samples within the field laboratory.

2.3.2 Rinse Blanks

Rinse blanks were prepared by rinsing decontaminated soil sampling equipment (augers, trowels, and bowls) with deionized water and collecting the rinsate for analysis. Rinse blanks were collected at a frequency of 7.3% of the field samples, which is more than the 5% (one for every twenty field samples) stated in the QAPP. Lead was reported above 0.01 mg/L in two rinse blanks, and both lead and arsenic were reported above 0.01 mg/L in two rinse blanks. The results demonstrate overall effective decontamination of soil sampling equipment. Sample results associated with these four rinse blanks were qualified as estimated (B).

2.3.3 Variability Tests

Intra-sample variability tests were performed to verify that homogenization of the composite sample was sufficient to reduce variability, which ensures that the portion that is prepared and analyzed is representative of the composite (and therefore representative of the property). Variability tests involved collecting and separately preparing three or seven aliquots of the homogenized composite sample. Tests were performed on six samples, where seven aliquots were prepared for three samples and three aliquots were prepared for the other three samples. For concentrations that were greater than the MDL, all test samples exhibited a percent relative standard deviation of less than 25%.

2.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Comparability was evaluated during Phase IIIB through preparation and analysis of confirmation soil samples.

2.4.1 Confirmation Samples

A percentage of the samples were split and prepared as confirmation samples. One confirmation sample was prepared for every ten field samples. The confirmation samples were submitted to an off-site, fixed laboratory for analysis by EPA Method 6010B, Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP). Results for blind standards submitted along with the confirmation samples are presented in Figures 15 through 18.

A portion of the confirmation sample results were qualified as estimated based on the laboratory's quality control data. However, no major anomalies were identified and no data were

If the field data from the sampled residential properties are to be considered normal, they should exhibit certain statistical characteristics. Among these include:

4) The coefficient of variation (CV) for the sample data generally should be in the range of the test data;
5) The CV should be below 1.0; and,
6) The maximum concentration observed at a residential property should not exceed the mean plus two standard deviations at more than 5% of the properties.

To test statistical characteristic number one, the CVs from 1456 properties were calculated and compared to the CVs in the simulated data, which ranged from 0.16 to 0.37, with associated means ranging from approximately 50 mg/kg to 500 mg/kg. The CVs for arsenic from the sampled properties with sample concentrations above the method detection limit generally fell within this range. Less than 8% of the arsenic CVs exceeded the upper range of the simulation data (0.37).

For statistical characteristic number two, if a CV exceeds 1.0, the data are generally considered to be non-normally distributed (USEPA 1996, Guidance for Data Quality Assessment, QA/G-9). A total of 30 residential properties exhibited CVs in excess of 1.0. This is approximately 2% of the residential properties and is attributable to concentrations either near the MDL or relatively high as compared to the proposed risk-based action levels.

To test statistical characteristic number three, the maximum concentration at each residential property was compared to the mean plus two standard deviations. No maximum sample concentration at any of the 1456 residential properties examined exceeded the mean plus two standard deviations. This provides an indication that the data from the residential properties do not violate the normality assumption.

In summary, the statistical characteristics of the sample data collected from the residential properties provide strong evidence that the sample data are normally distributed. Exceptions are restricted to very low and high concentrations, which should not impair decision making with regard to risk management.

Table 1

PHASE IIIB SOIL SAMPLING ANALYTICAL PROGRAM SUMMARY

SAMPLE TYPE	TOTAL
Field Samples	4368
Blind Duplicates	223
Lab Duplicates	264
Blind Standards	180
Lab Control Sample (SRM)	909
Instrument Blanks	369
Method Blanks	112
MDL Study Samples	63
Proficiency Samples	28
Variability Test Samples	30
Other Test Samples	83
Off-Site Confirmation Samples	422
Equipment Blanks	319
TOTAL SAMPLES	**7370**

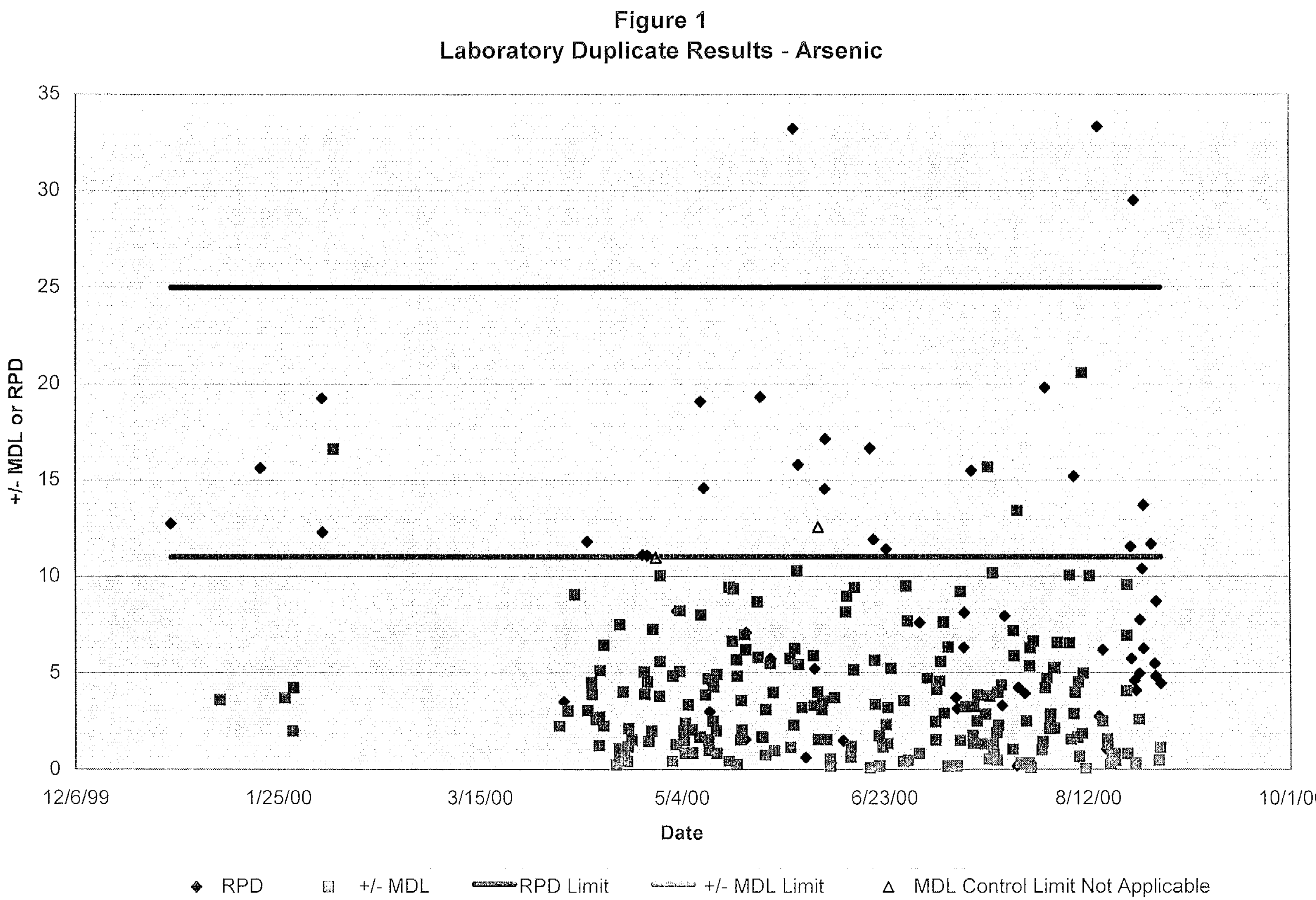


Figure 1
Laboratory Duplicate Results - Arsenic
35
30
25
20
15
10
5
0
+/- MDL or RPD
12/6/99
1/25/00
3/15/00
5/4/00
6/23/00
8/12/00
10/1/00
Date
RPD
+/- MDL
RPD Limit
+/- MDL Limit
MDL Control Limit Not Applicable

Figure 2
Laboratory Duplicate Results - Lead

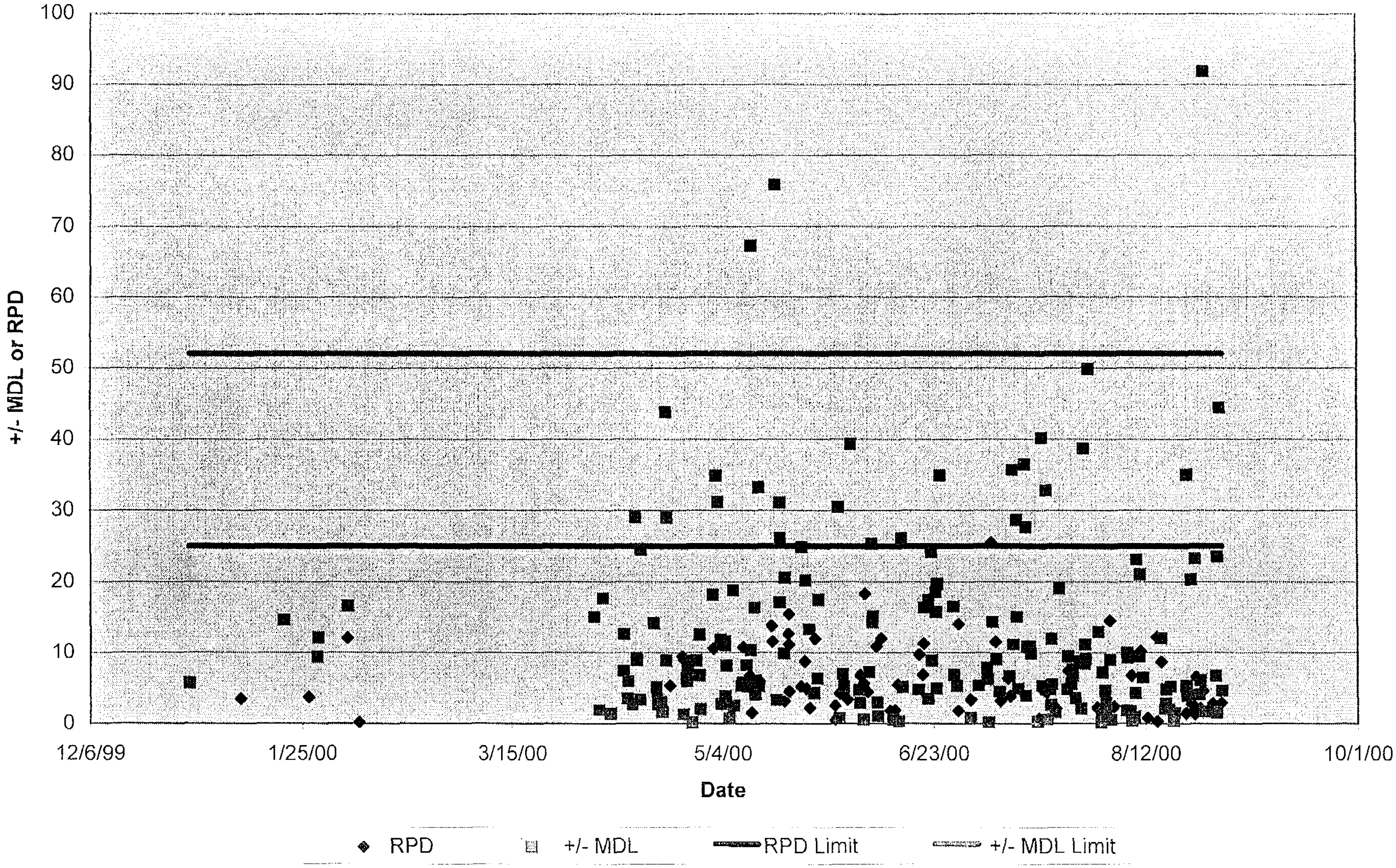


Figure 3
Laboratory Duplicate Correlation - Arsenic

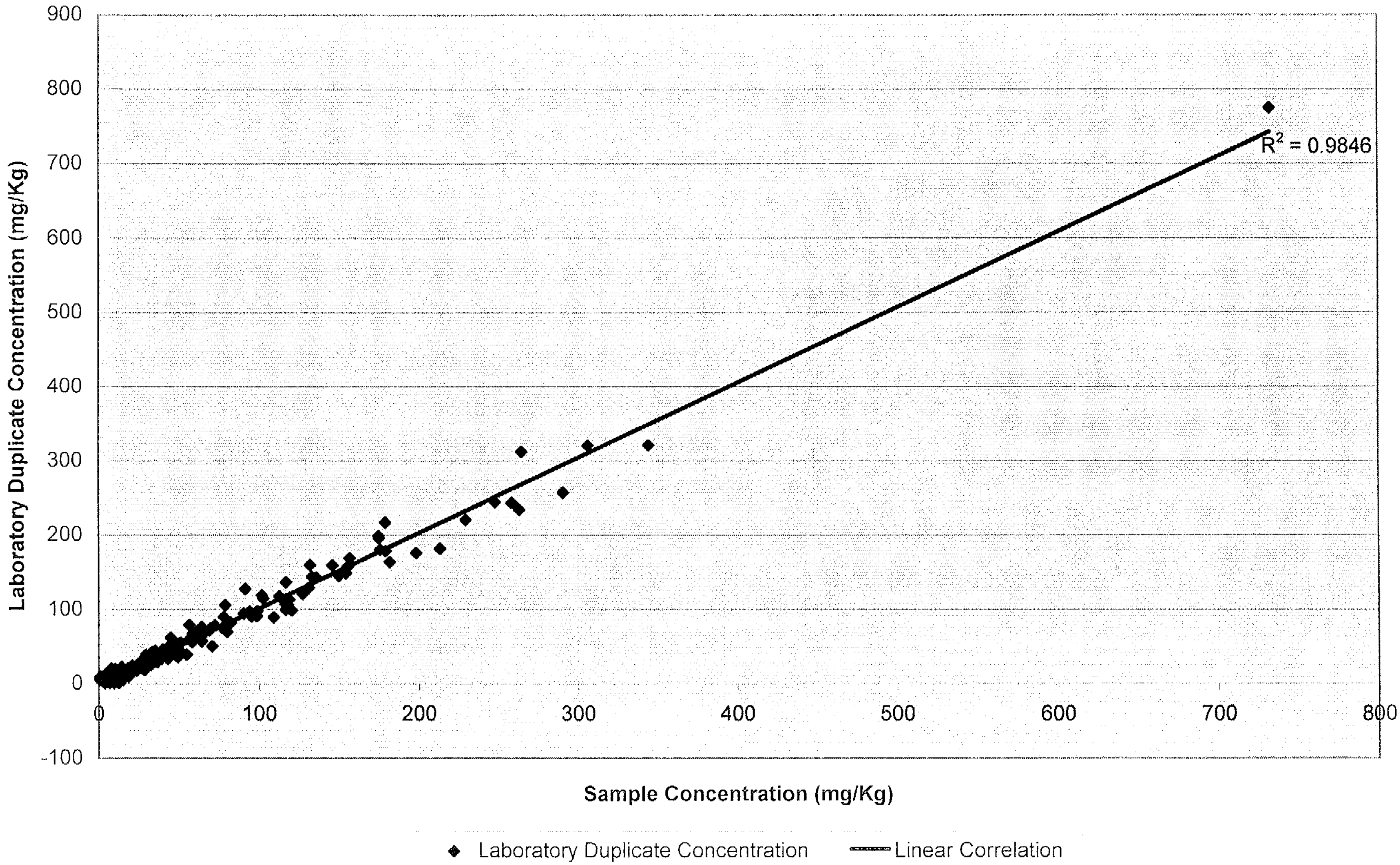


Figure 4
Laboratory Duplicate Correlation - Lead

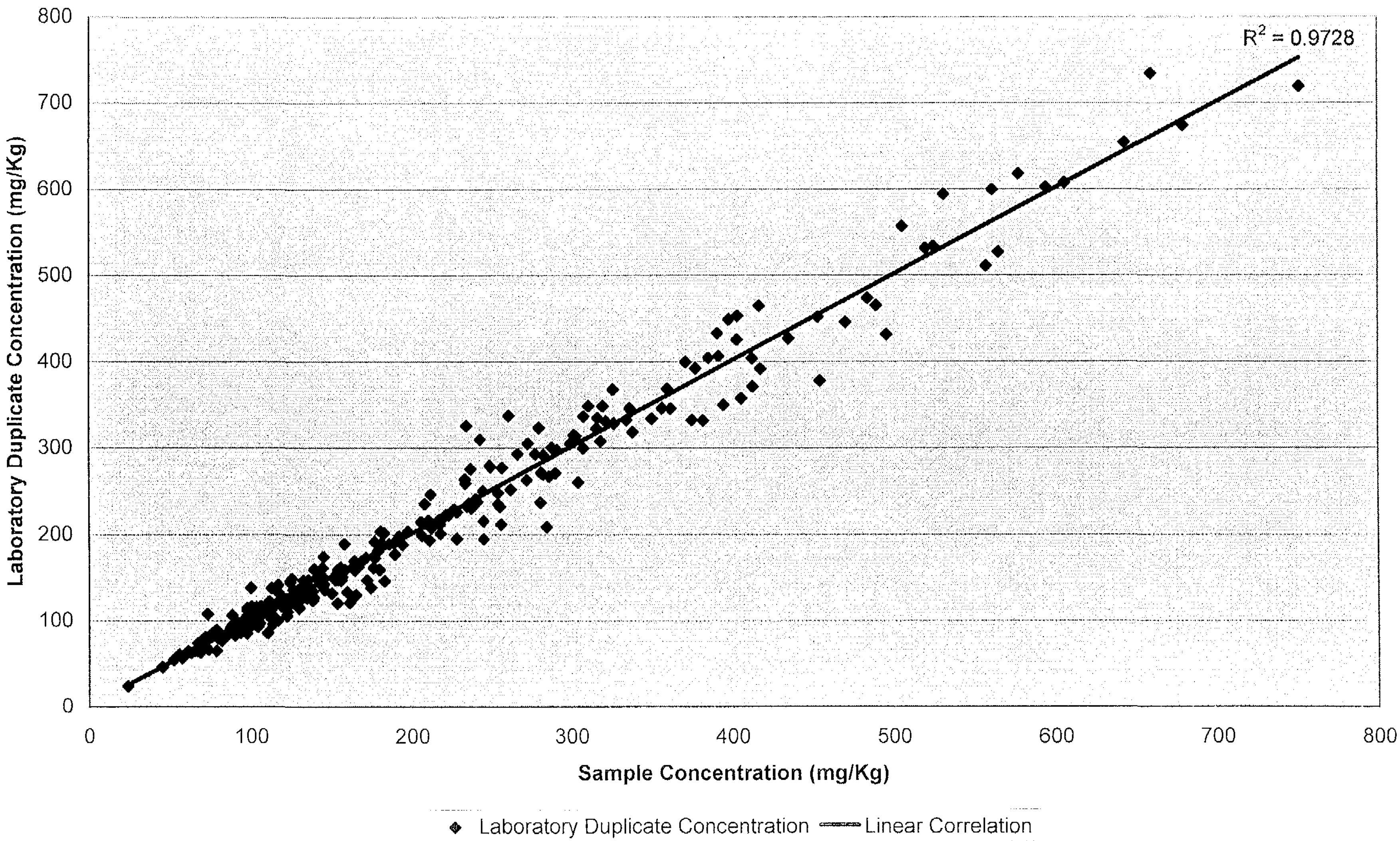


Figure 5
Blind Split Results - Arsenic

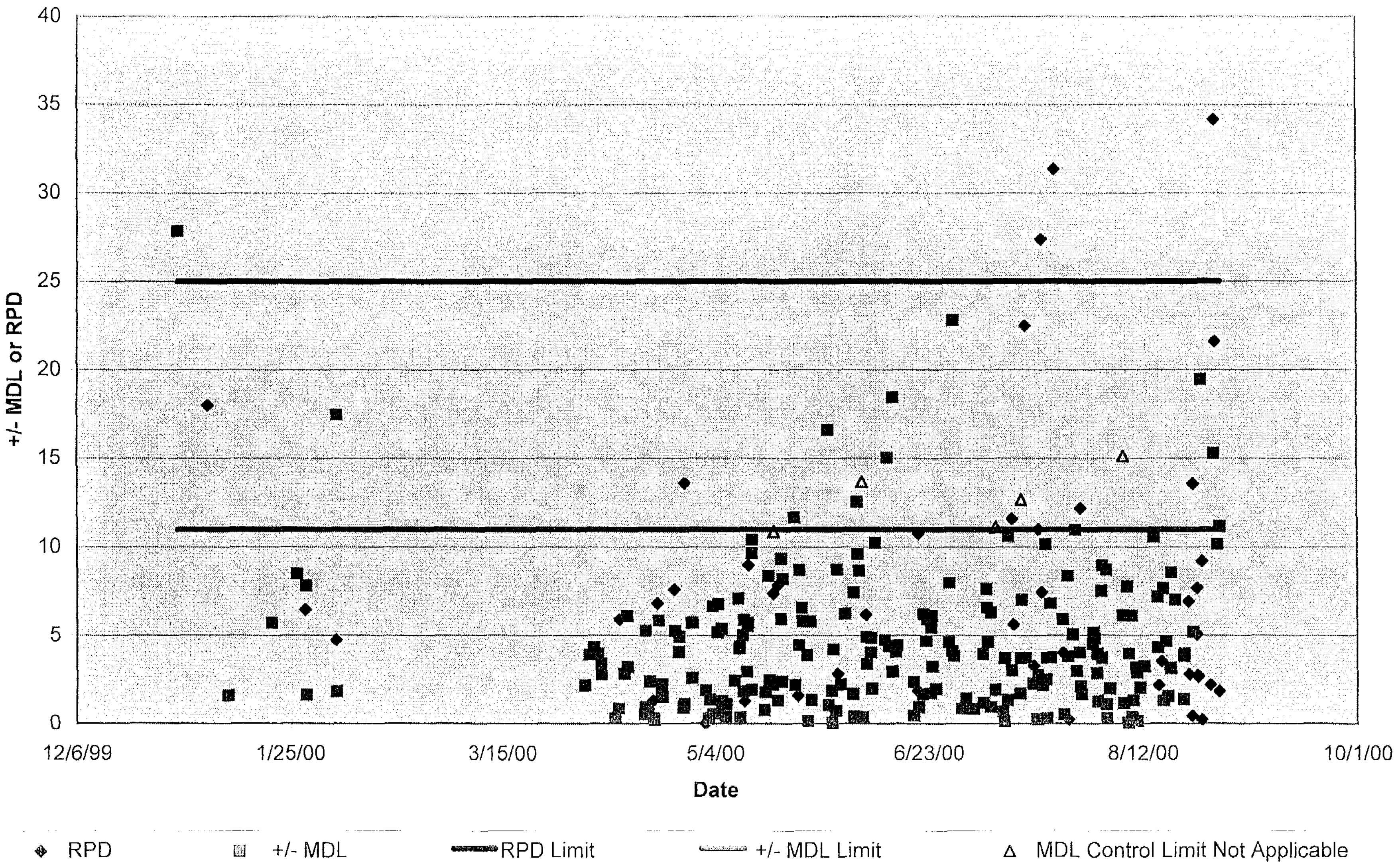


Figure 6
Blind Split Results - Lead

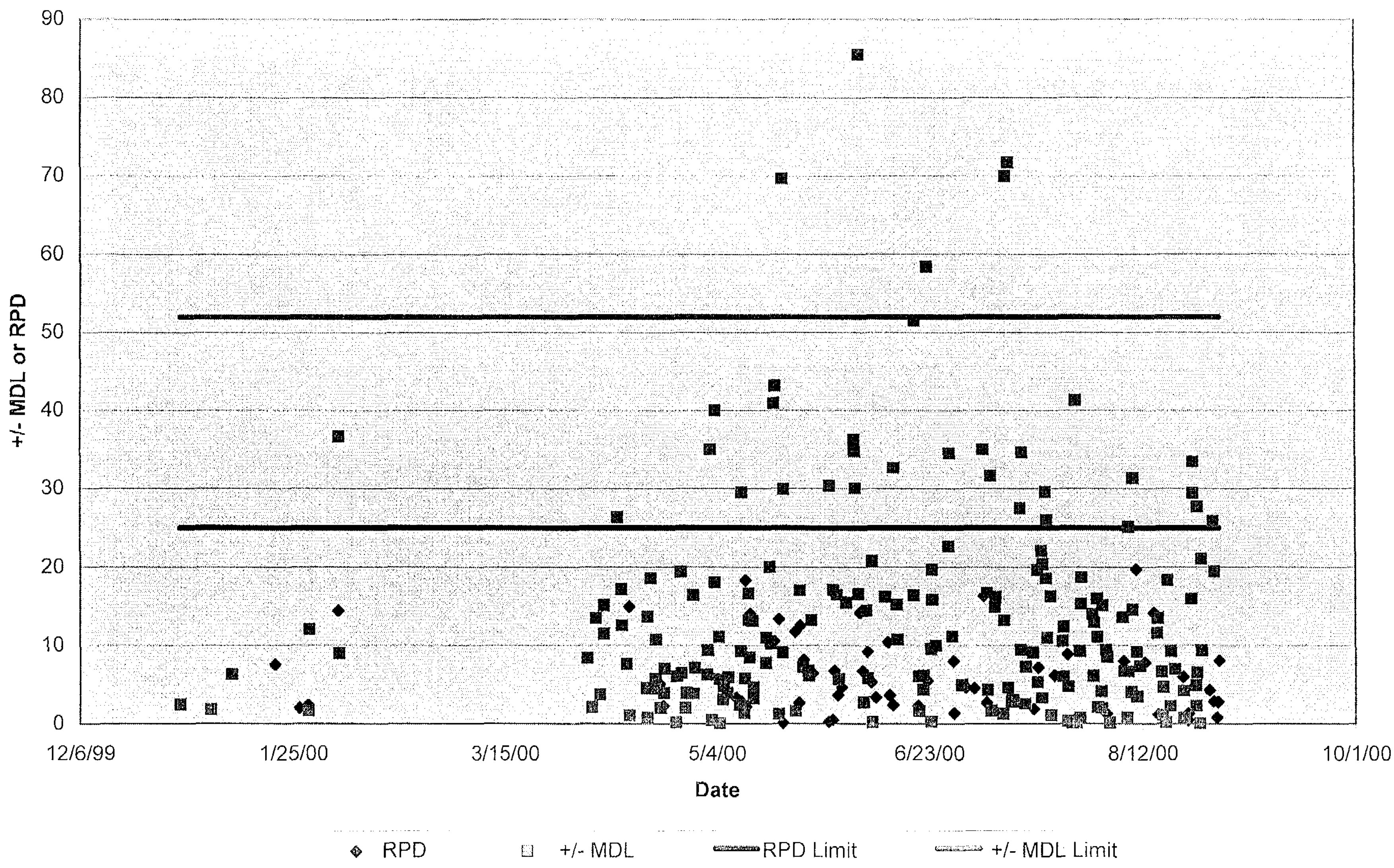


Figure 7
Blind Split Correlation - Arsenic

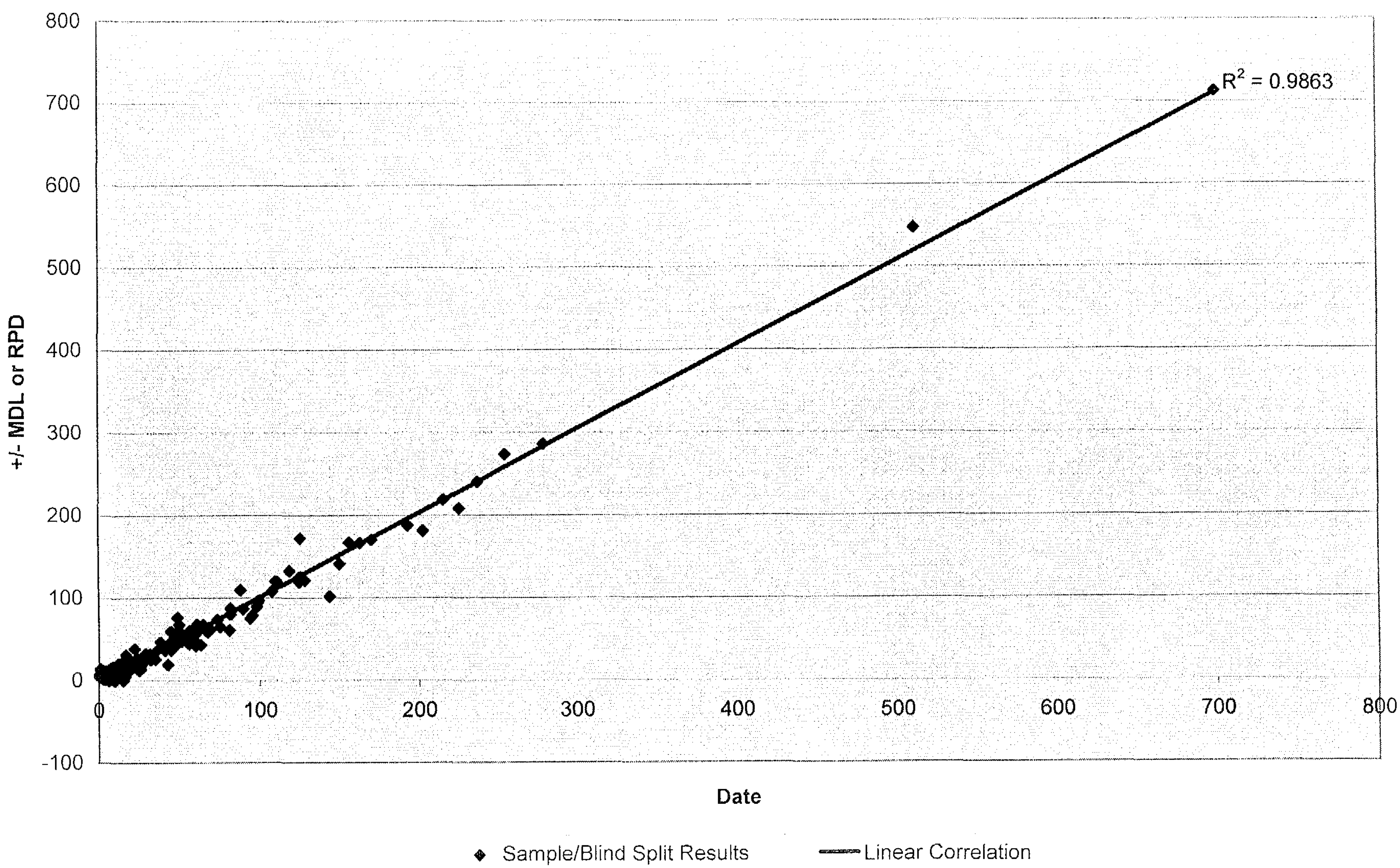


Figure 8
Blind Split Correlation - Lead

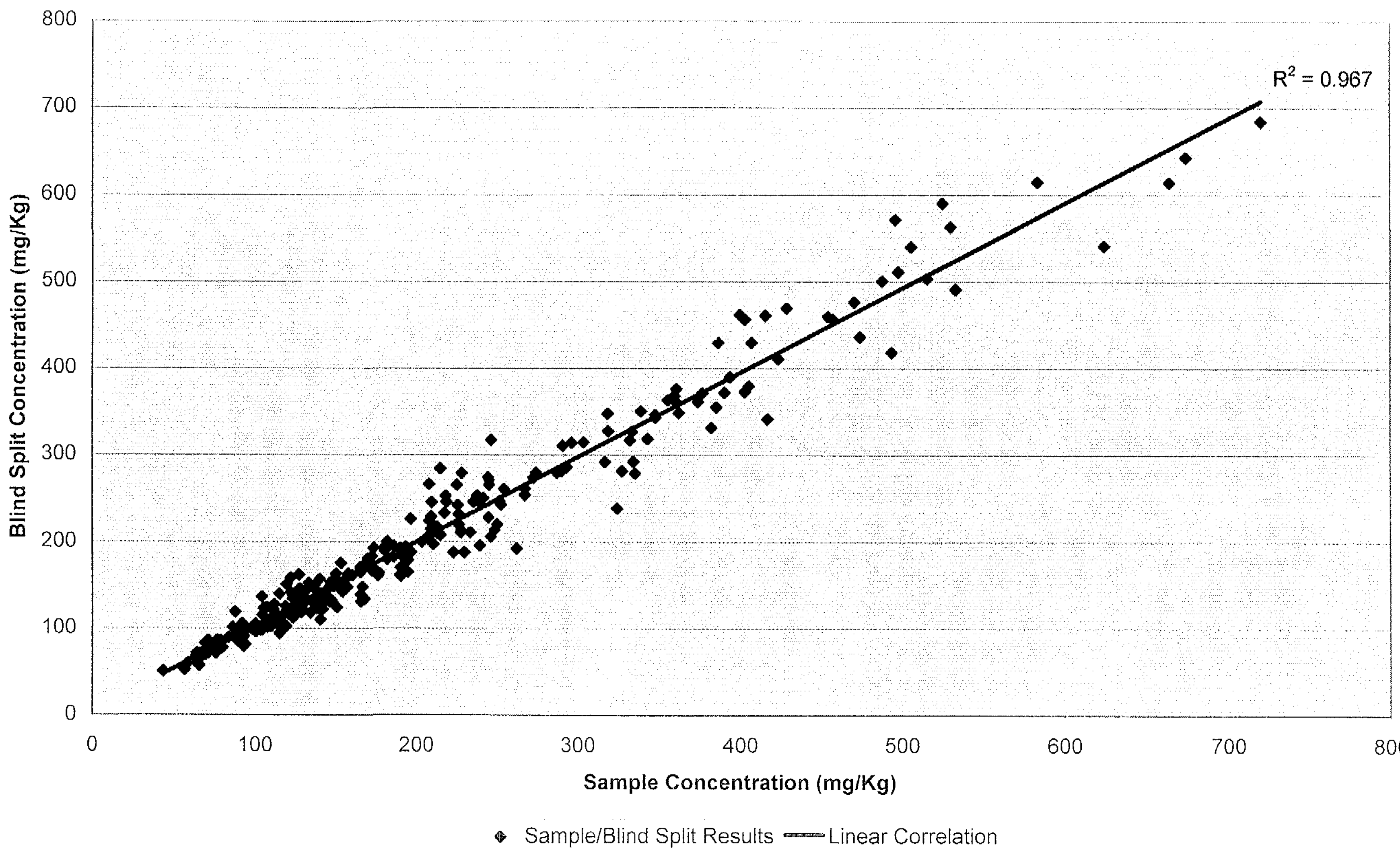
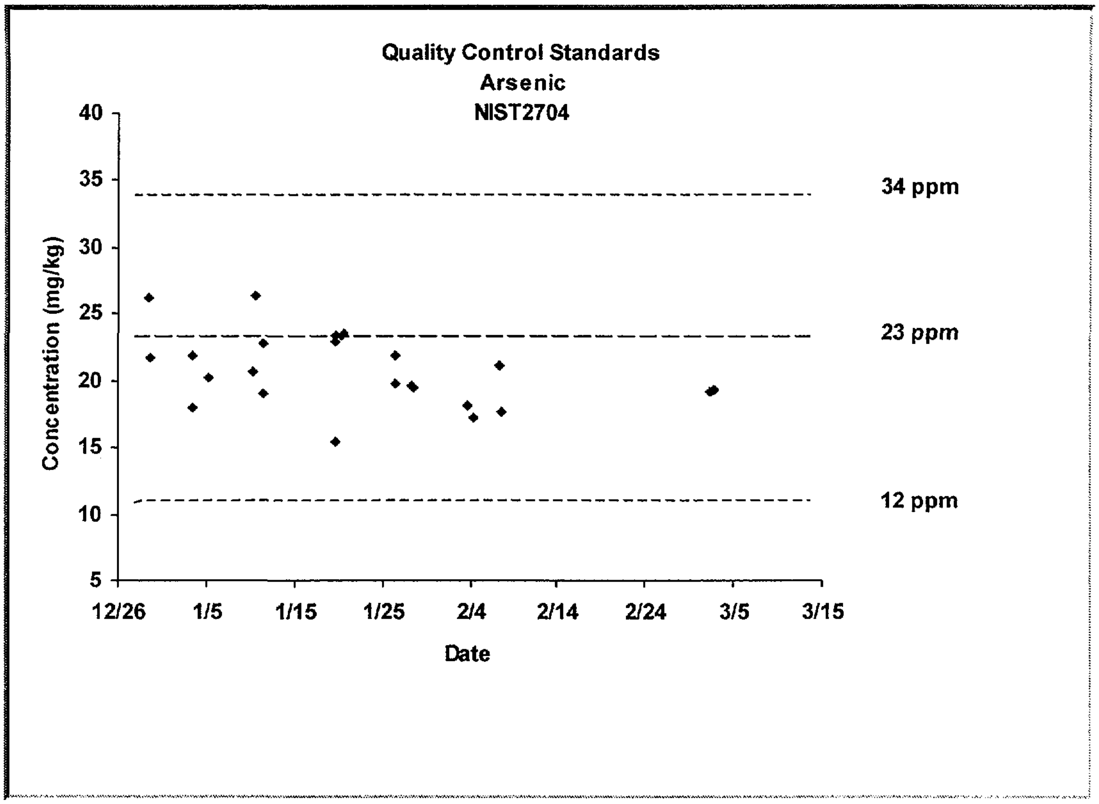
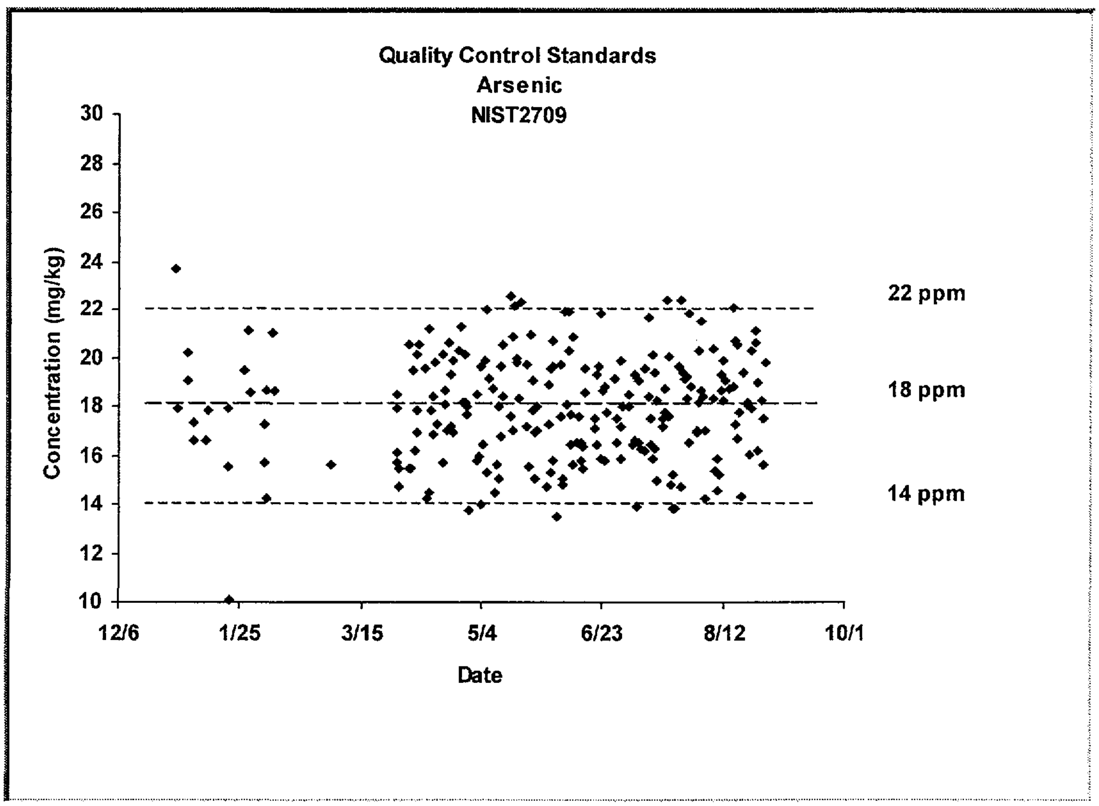


Figure 9

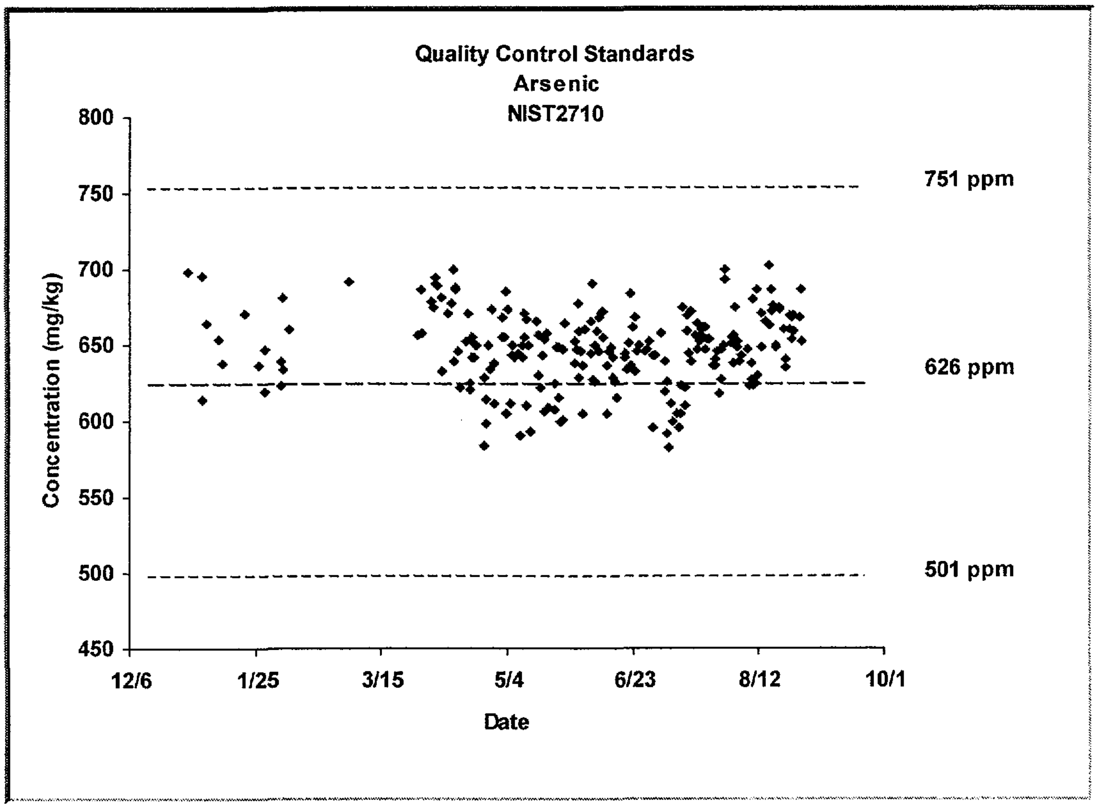


Quality Control Standards
Arsenic
NIST2704
Concentration (mg/kg)
40
35
30
25
20
15
10
5
34 ppm
23 ppm
12 ppm
12/26
1/5
1/15
1/25
2/4
2/14
2/24
3/5
3/15
Date



Quality Control Standards
Arsenic
NIST2709
Concentration (mg/kg)
30
28
26
24
22
20
18
16
14
12
10
22 ppm
18 ppm
14 ppm
12/6
1/25
3/15
5/4
6/23
8/12
10/1
Date

Figure 10



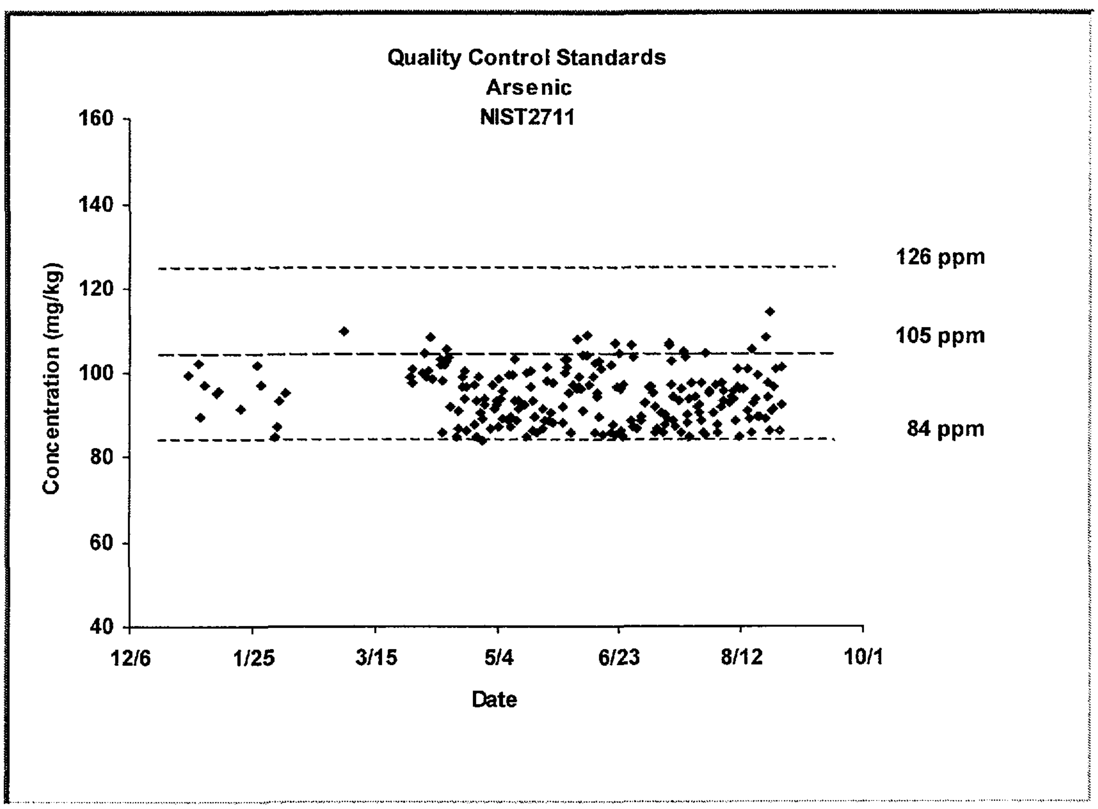


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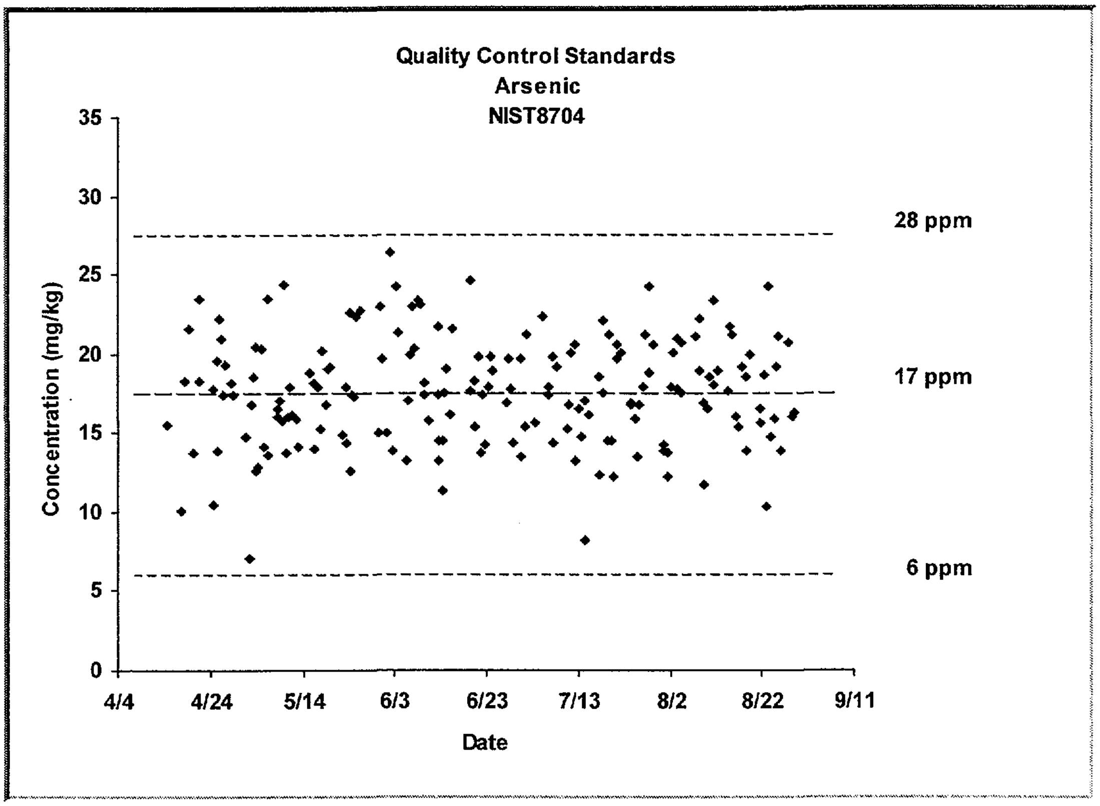
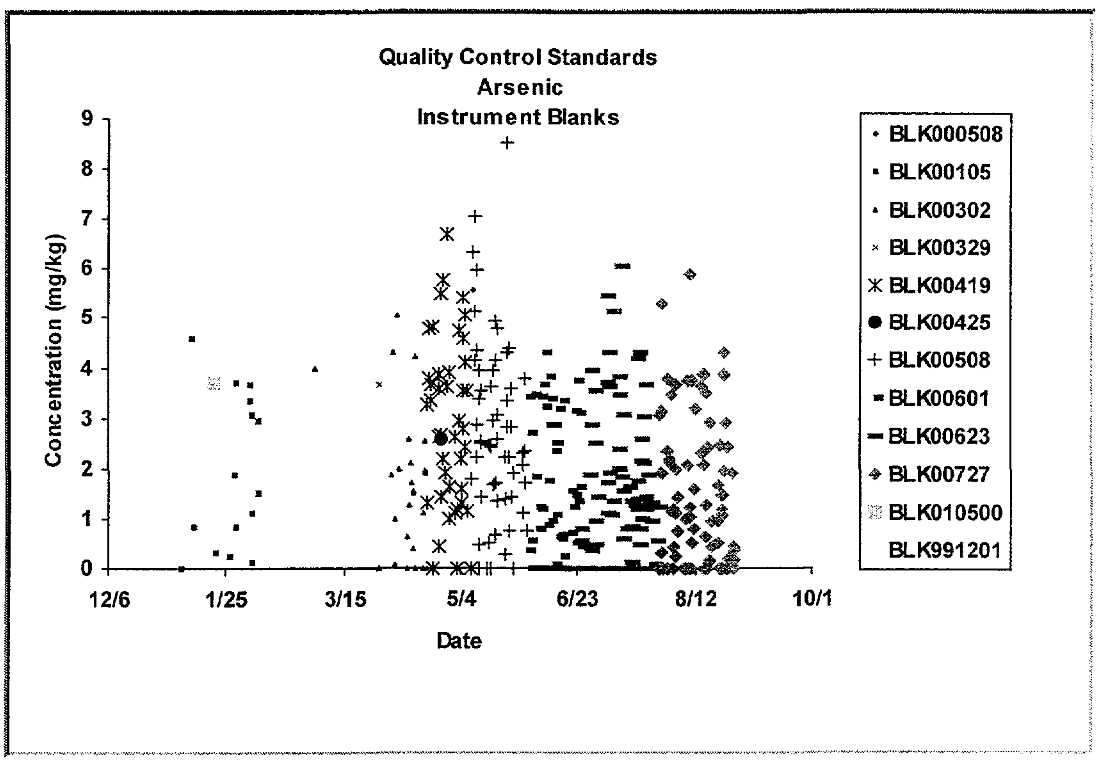
Figure 11





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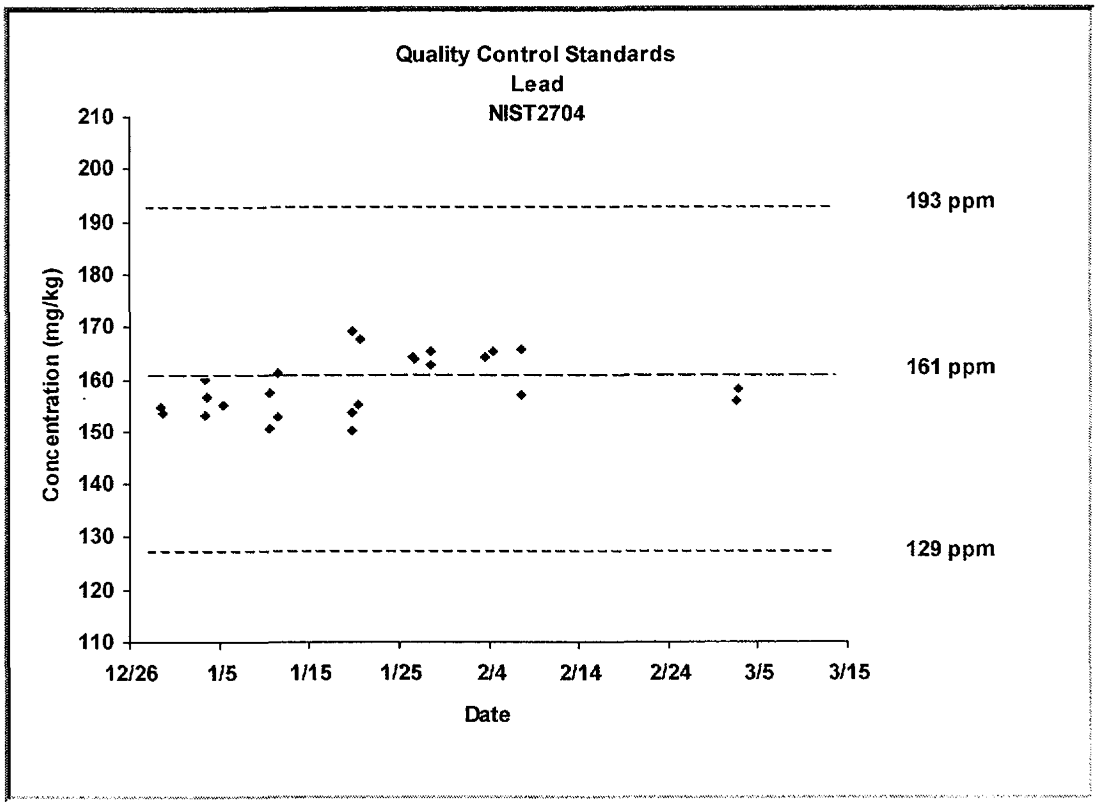

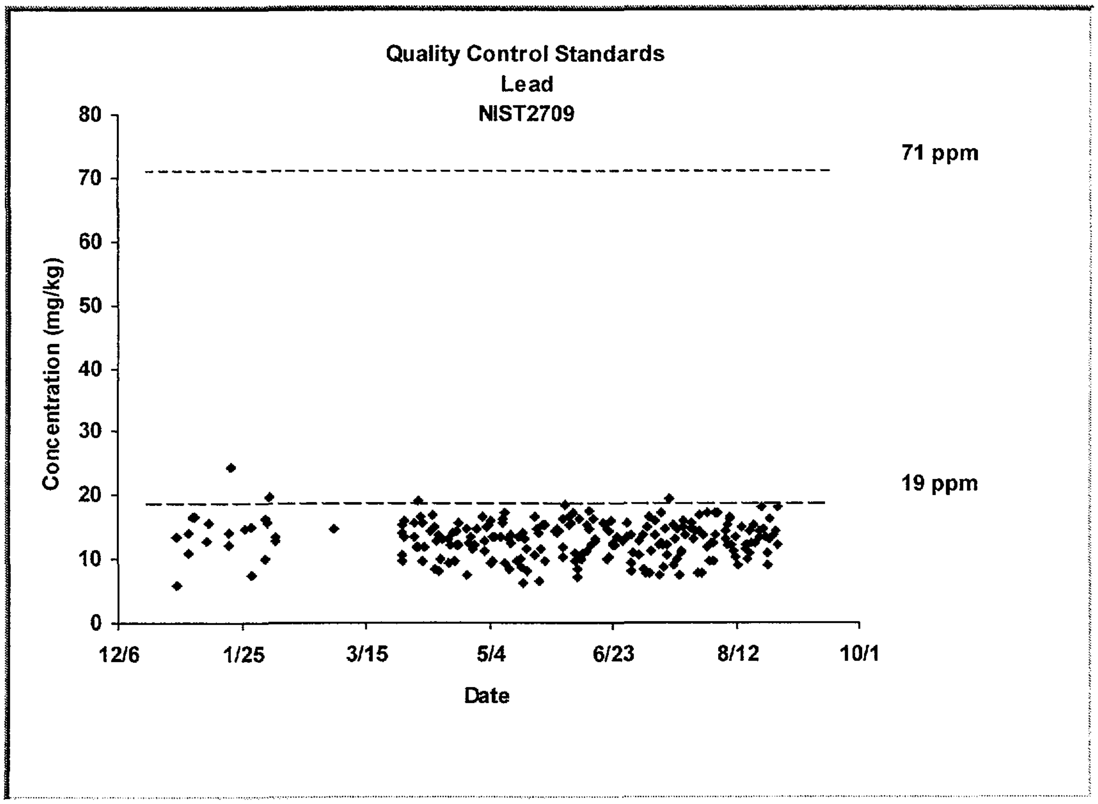

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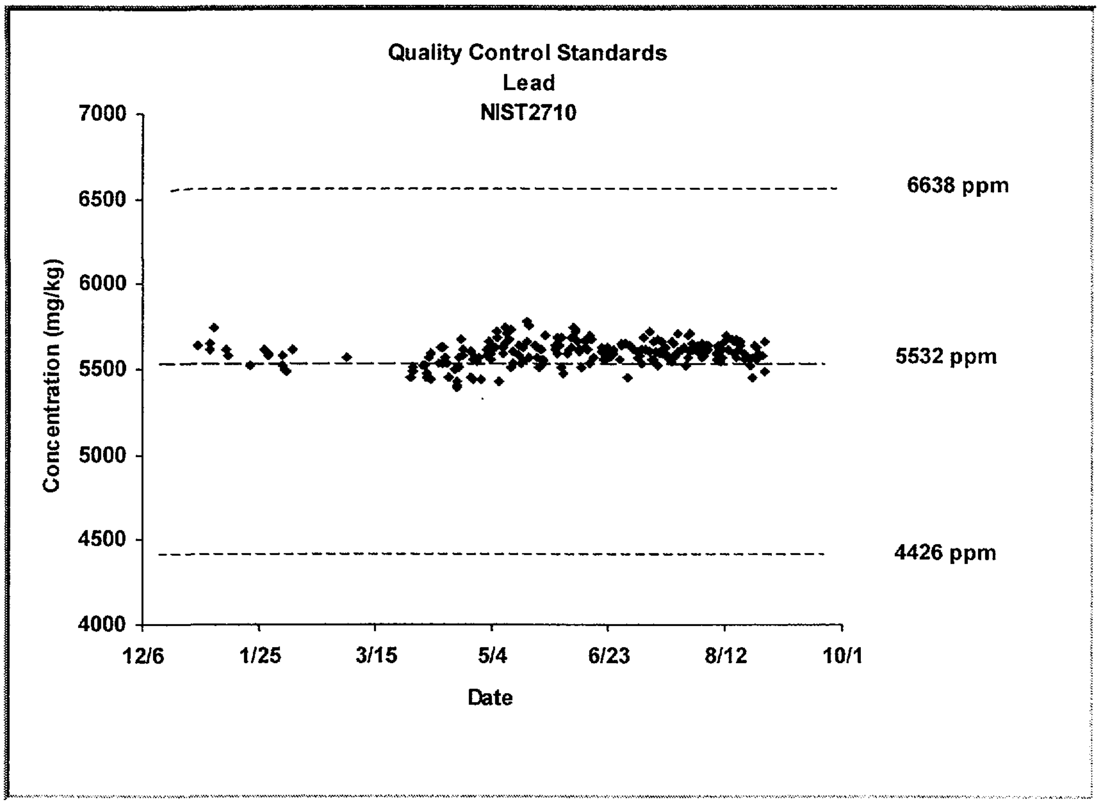

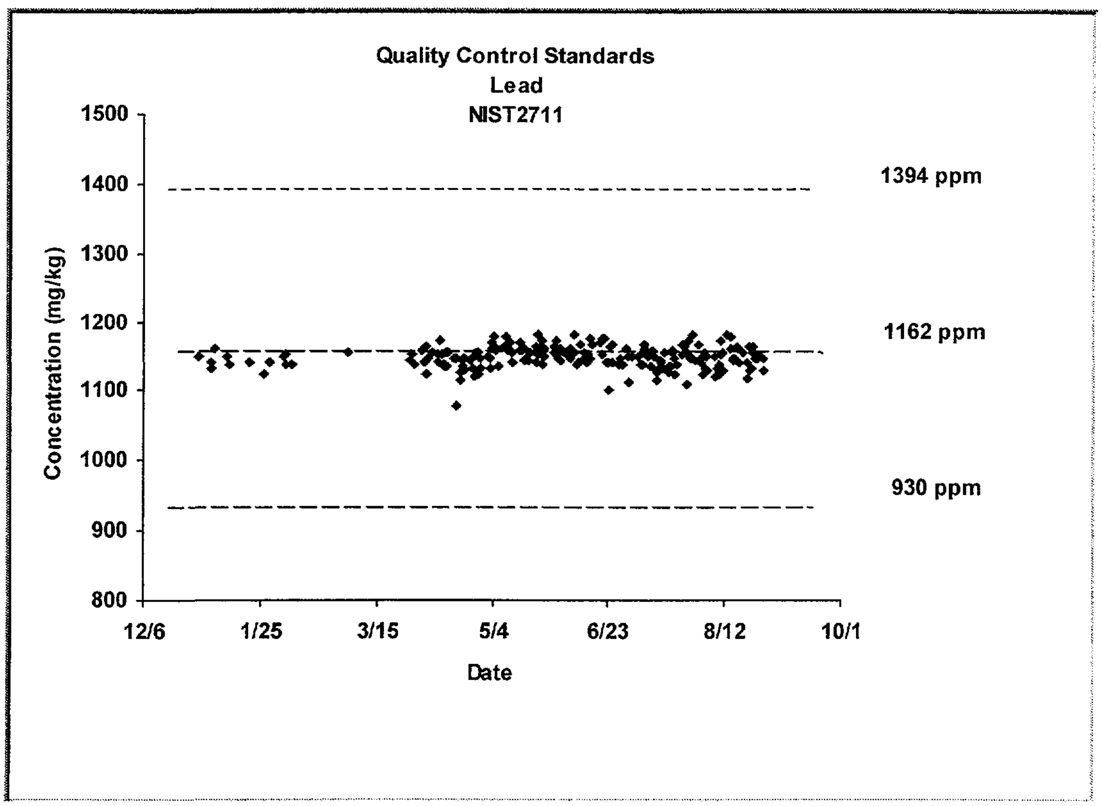

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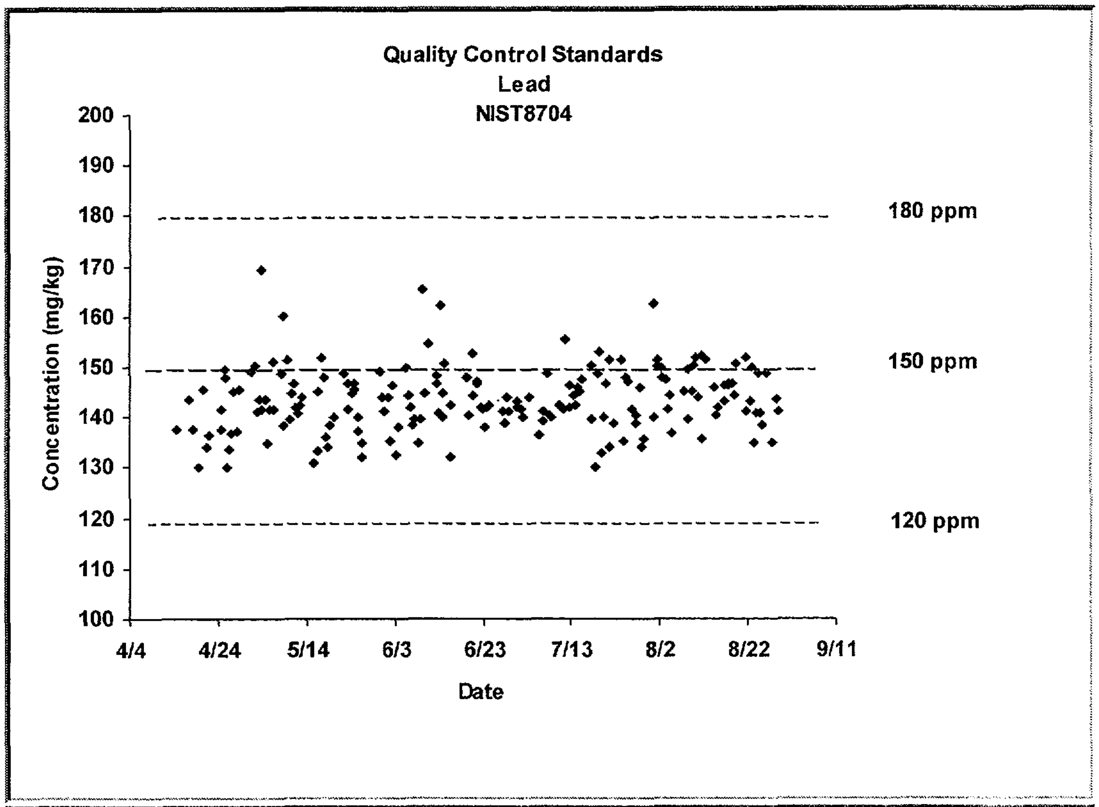

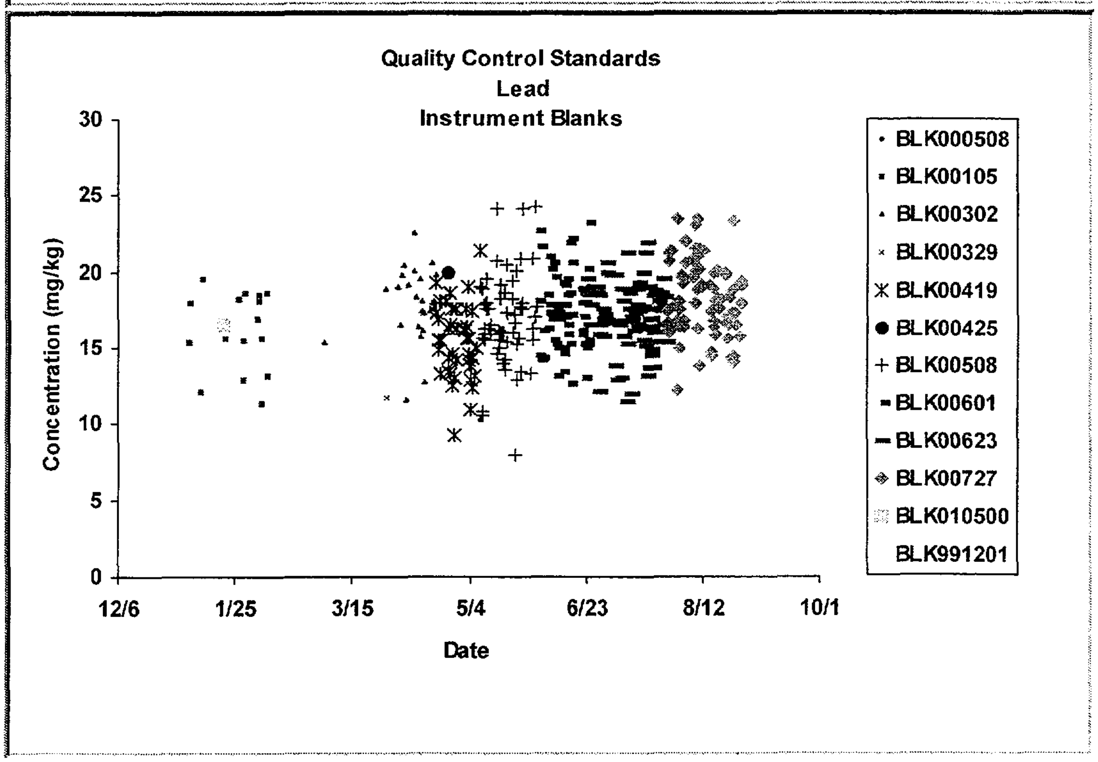

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Figure 15
Blind Standards A, B, C, and D - Arsenic

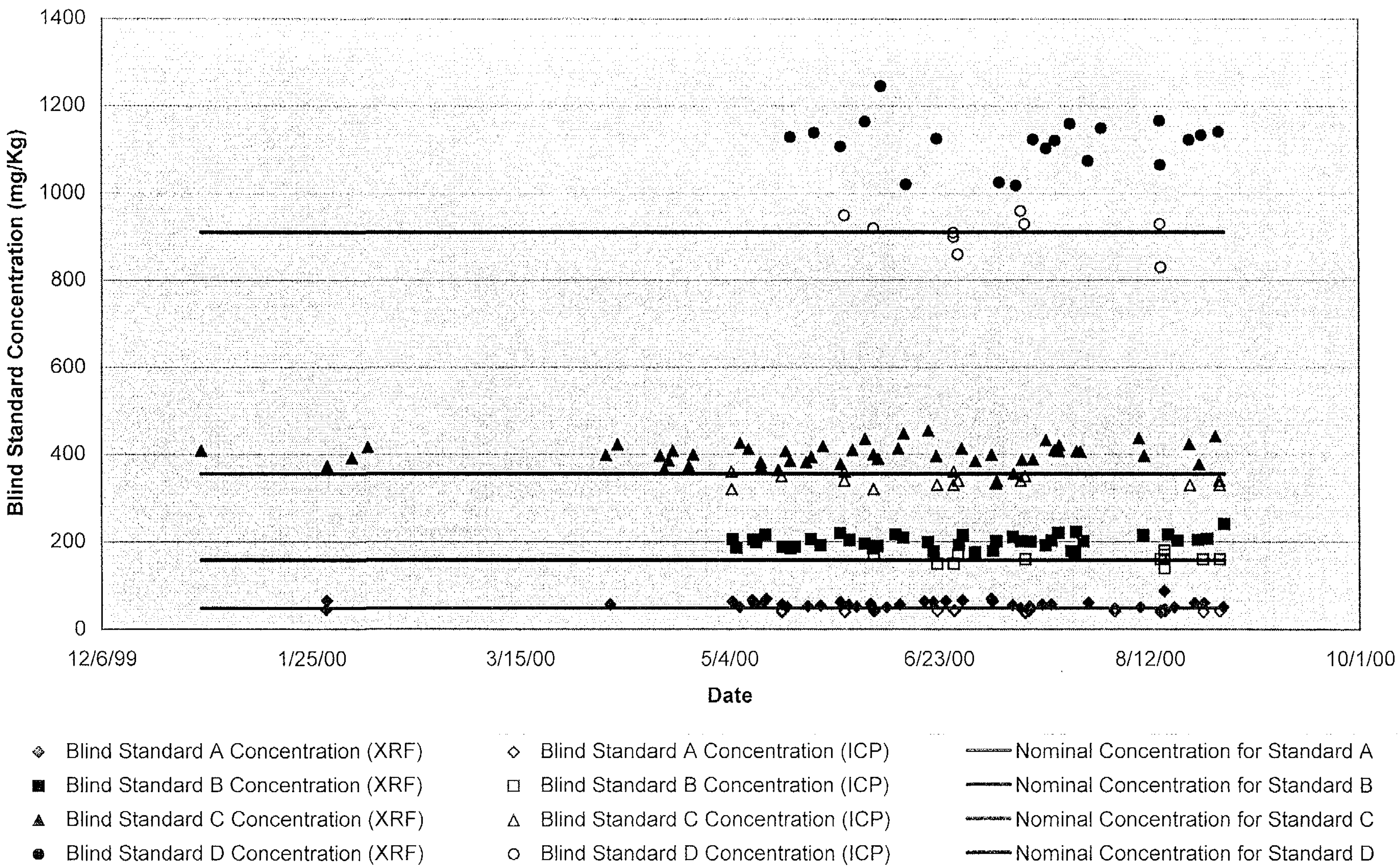


Figure 16
Blind Standards E and F - Arsenic

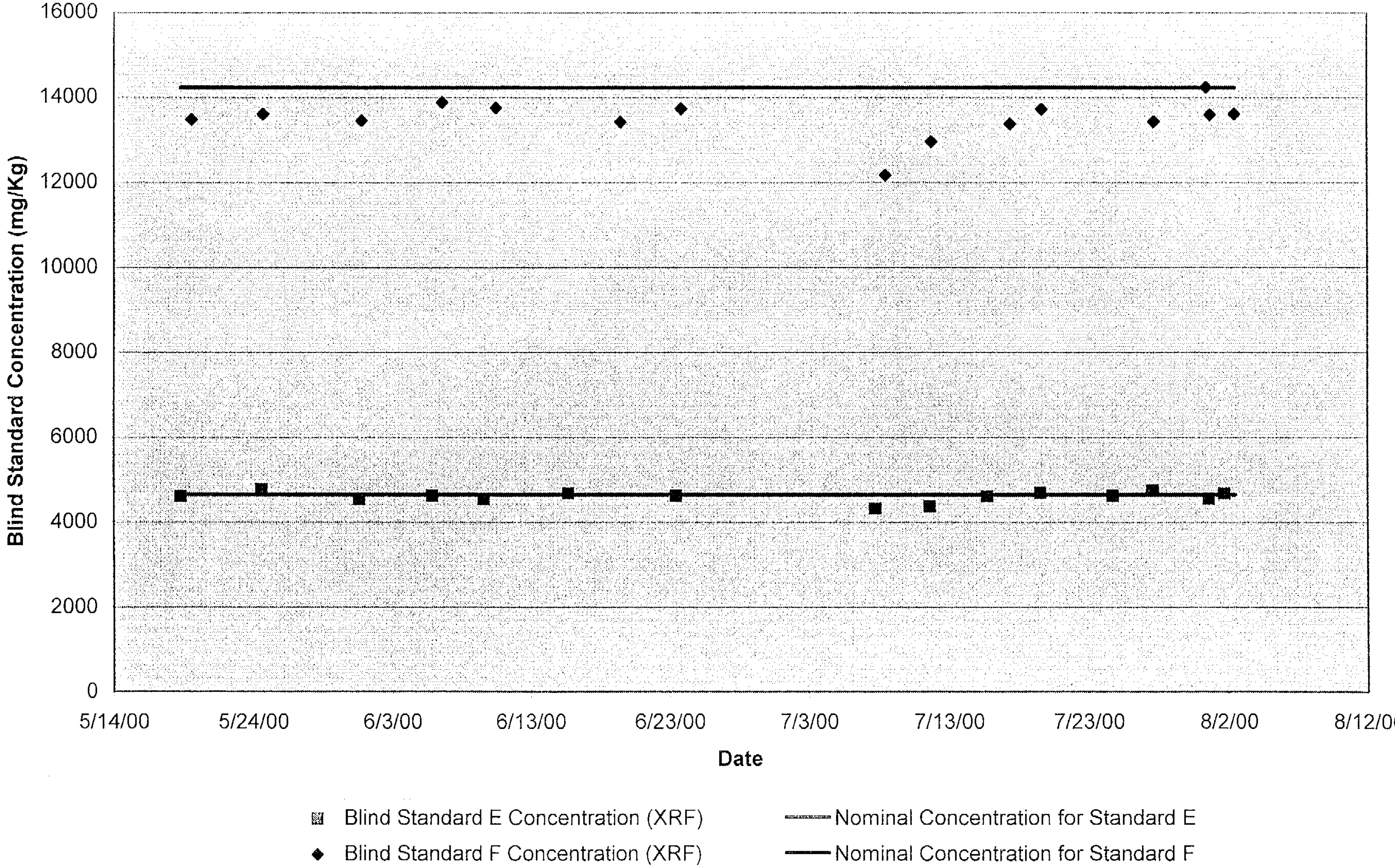


Figure 17
Blind Standards A, B, C, and D - Lead

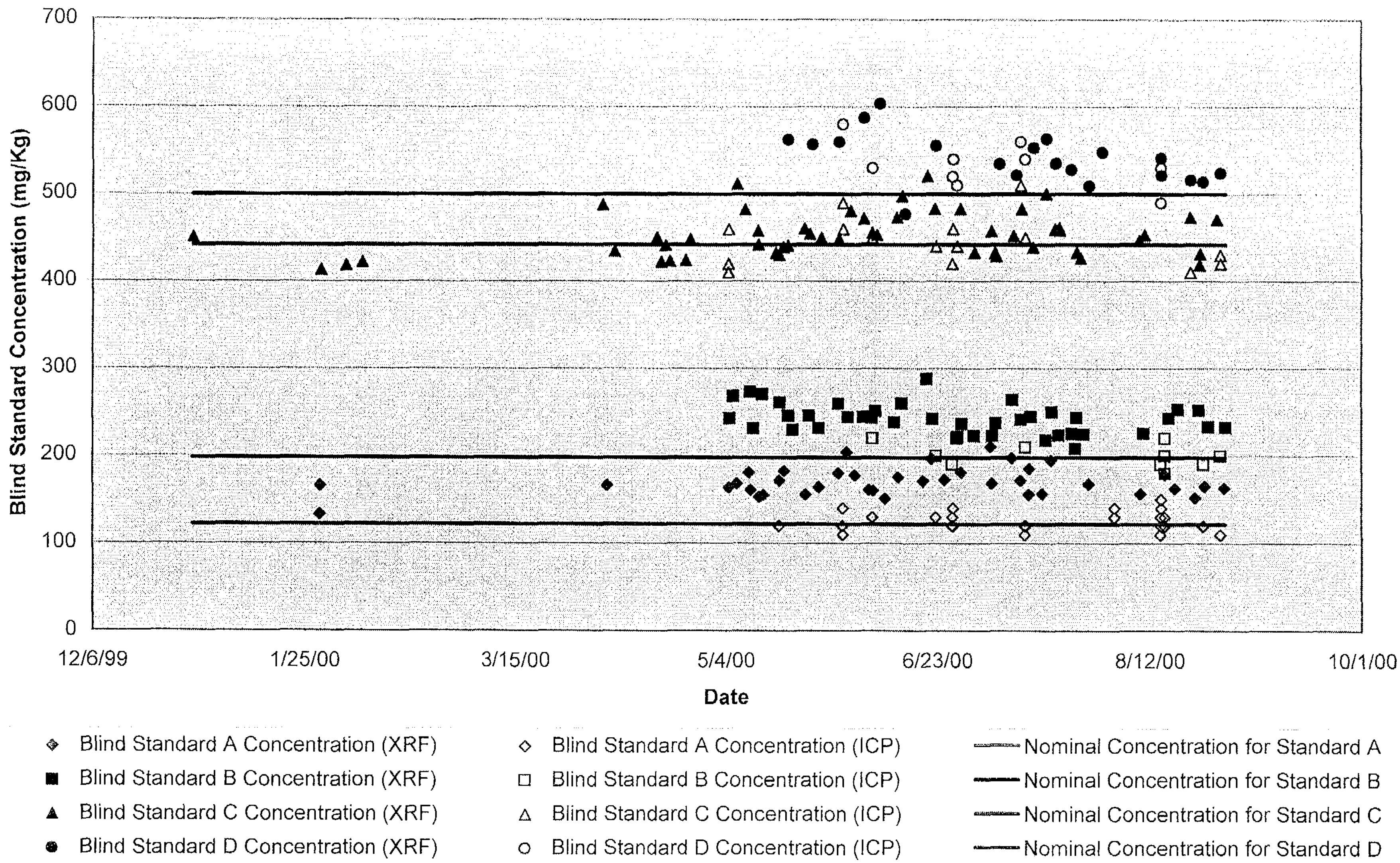


Figure 18
Blind Standards E and F - Lead

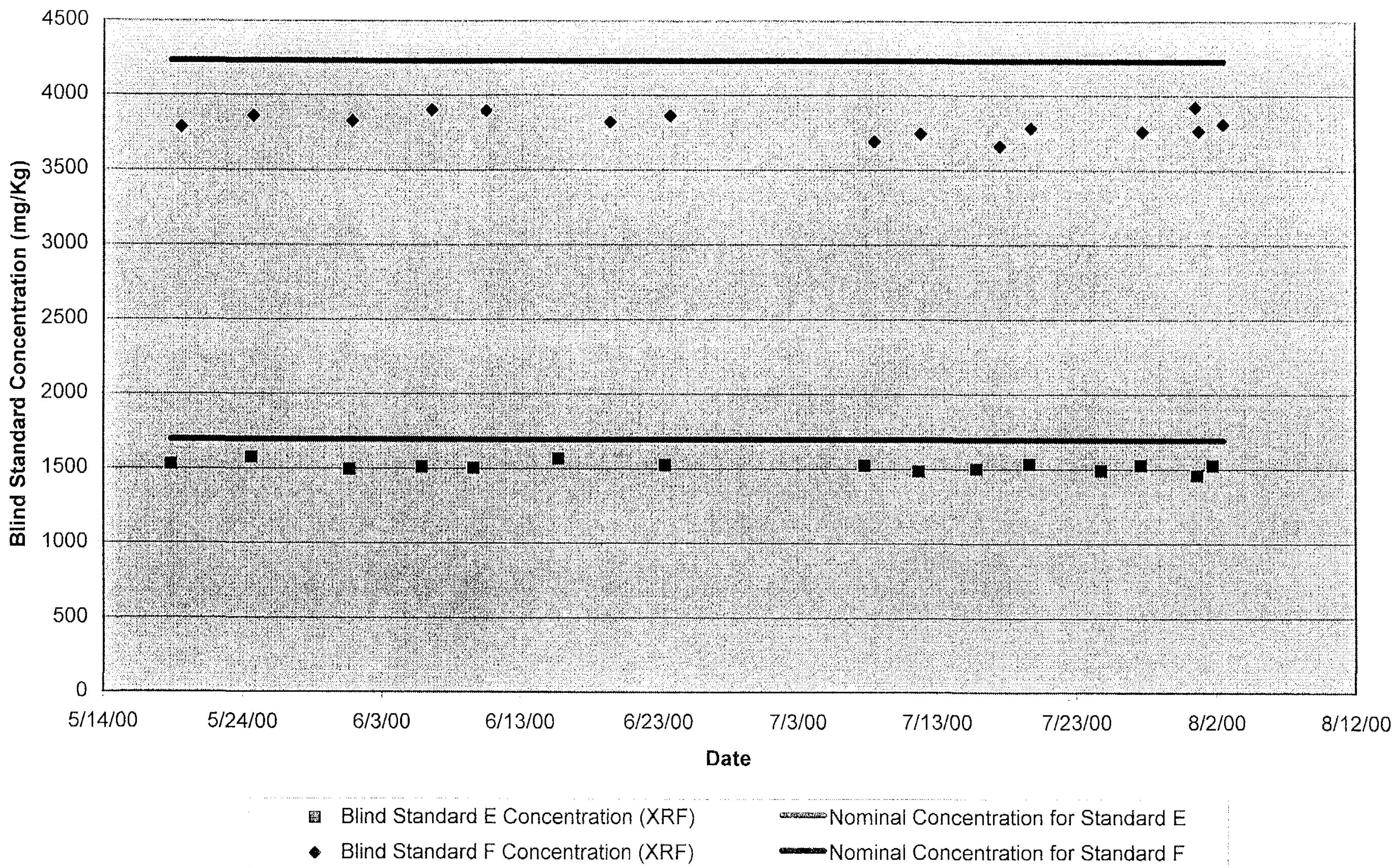
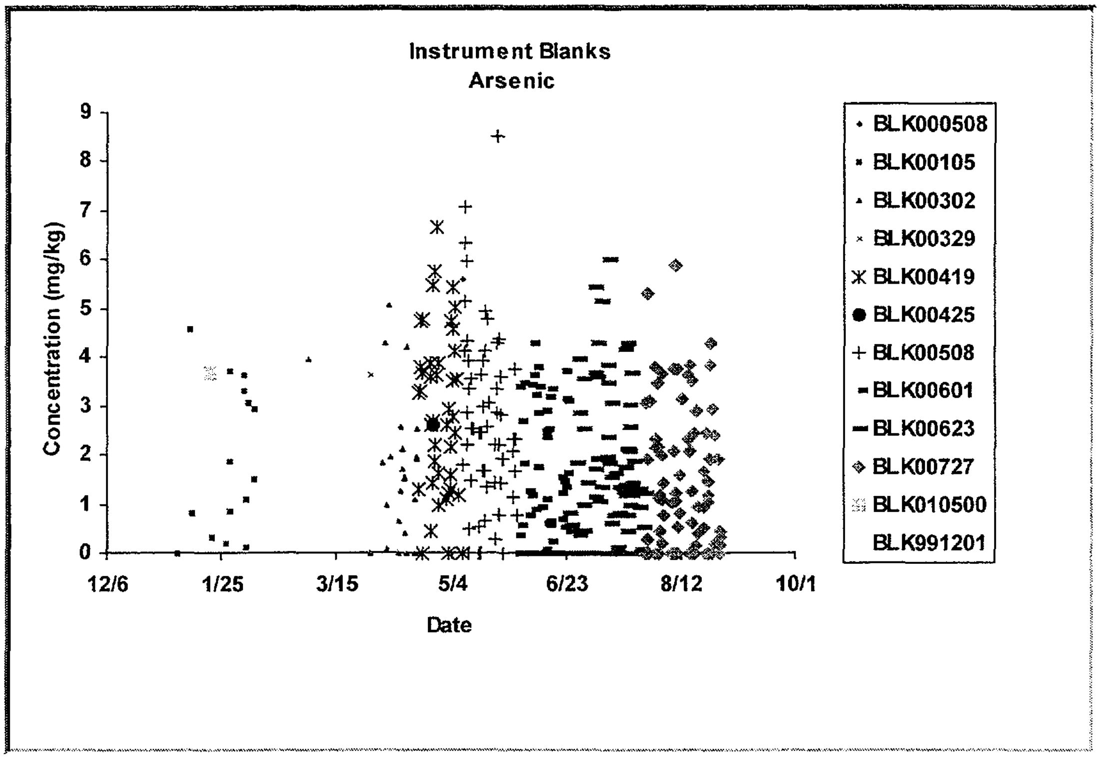


Figure 19


Instrument Blanks
Arsenic
Concentration (mg/kg)
0
1
2
3
4
5
6
7
8
9
12/6
1/25
3/15
5/4
6/23
8/12
10/1
Date
BLK000508
BLK00105
BLK00302
BLK00329
BLK00419
BLK00425
BLK00508
BLK00601
BLK00623
BLK00727
BLK010500
BLK991201

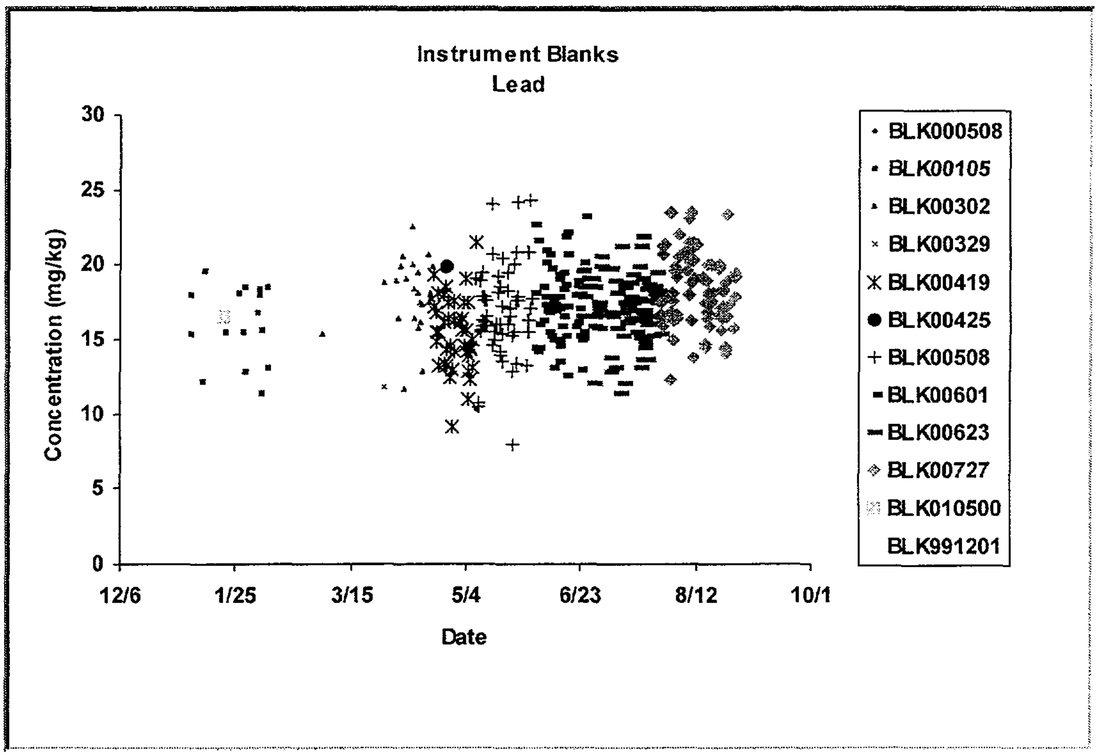
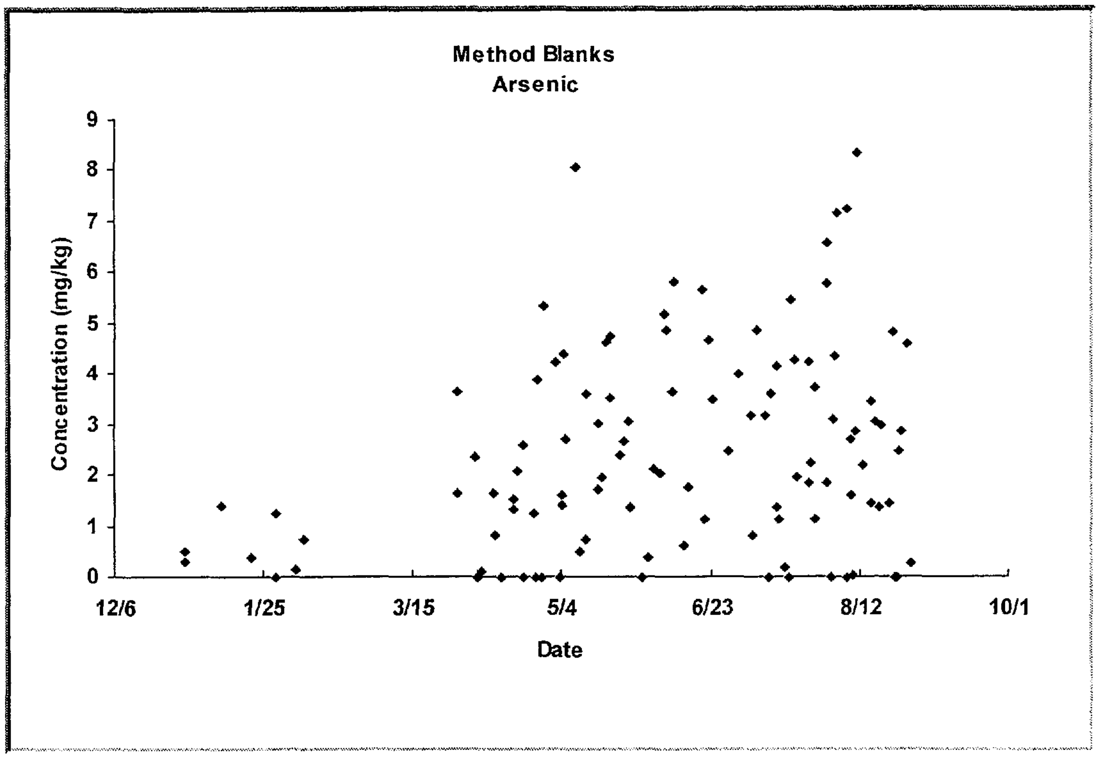
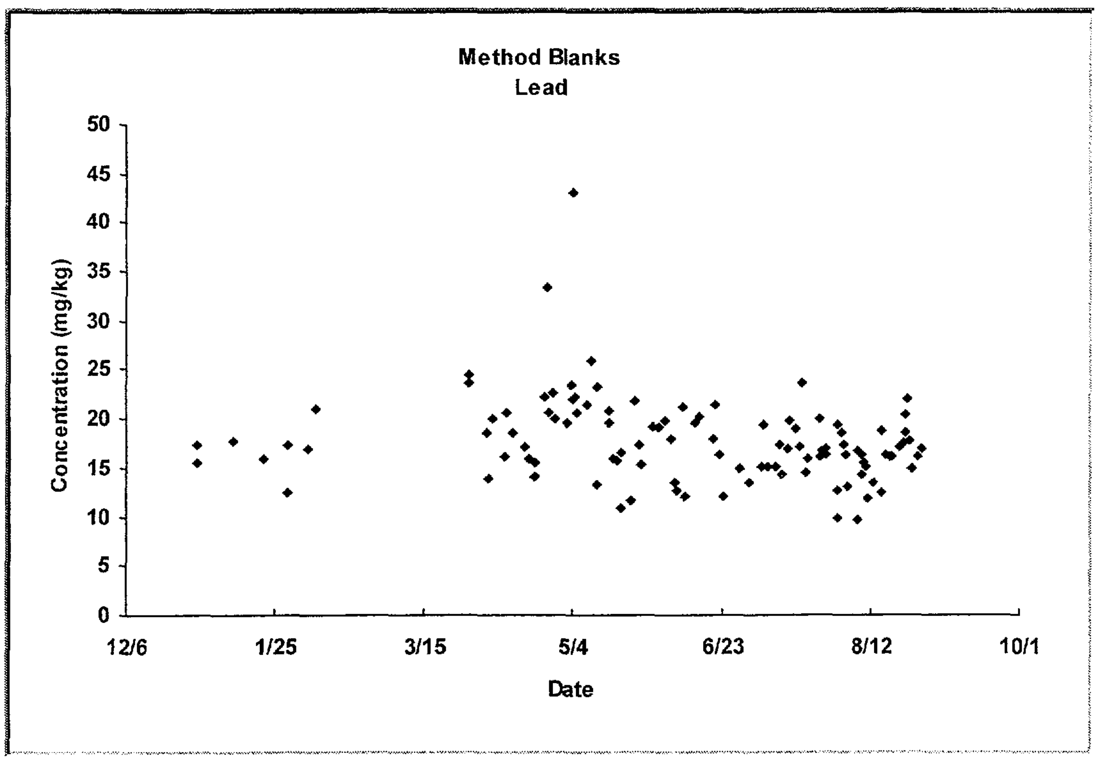

Instrument Blanks
Lead
Concentration (mg/kg)
0
5
10
15
20
25
30
12/6
1/25
3/15
5/4
6/23
8/12
10/1
Date
BLK000508
BLK00105
BLK00302
BLK00329
BLK00419
BLK00425
BLK00508
BLK00601
BLK00623
BLK00727
BLK010500
BLK991201

Figure 20

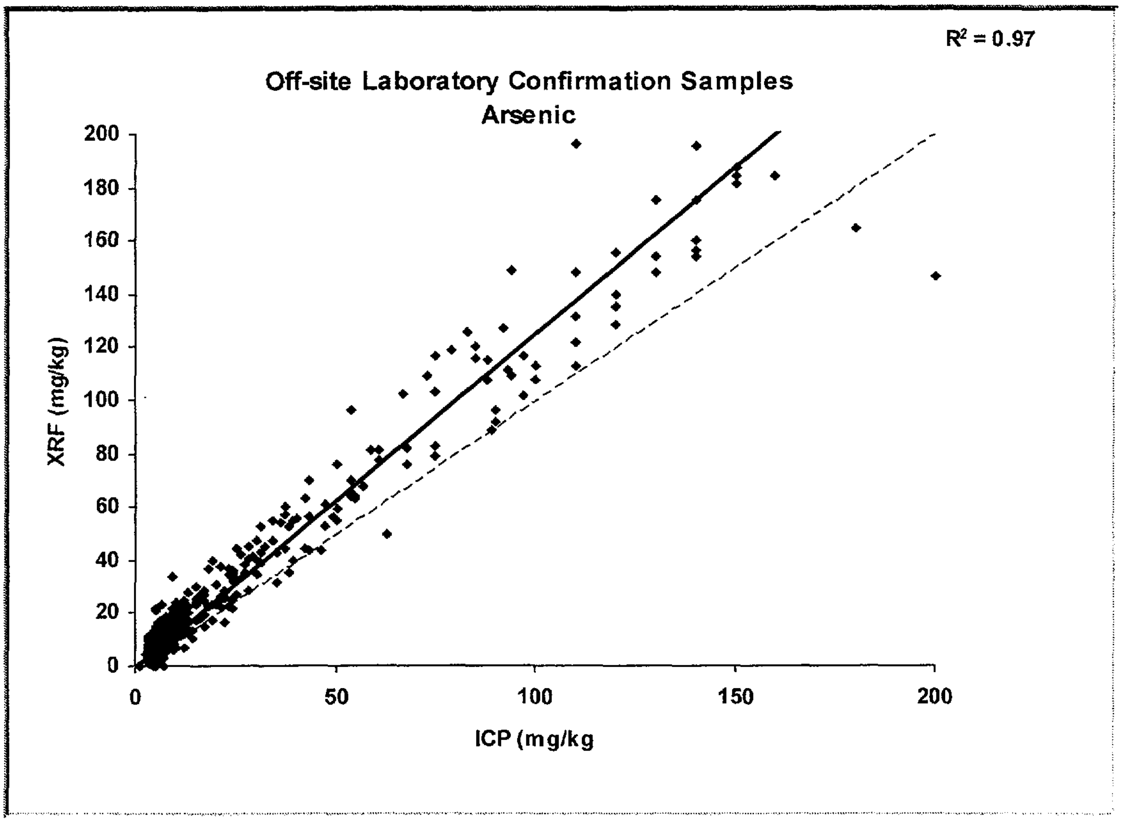


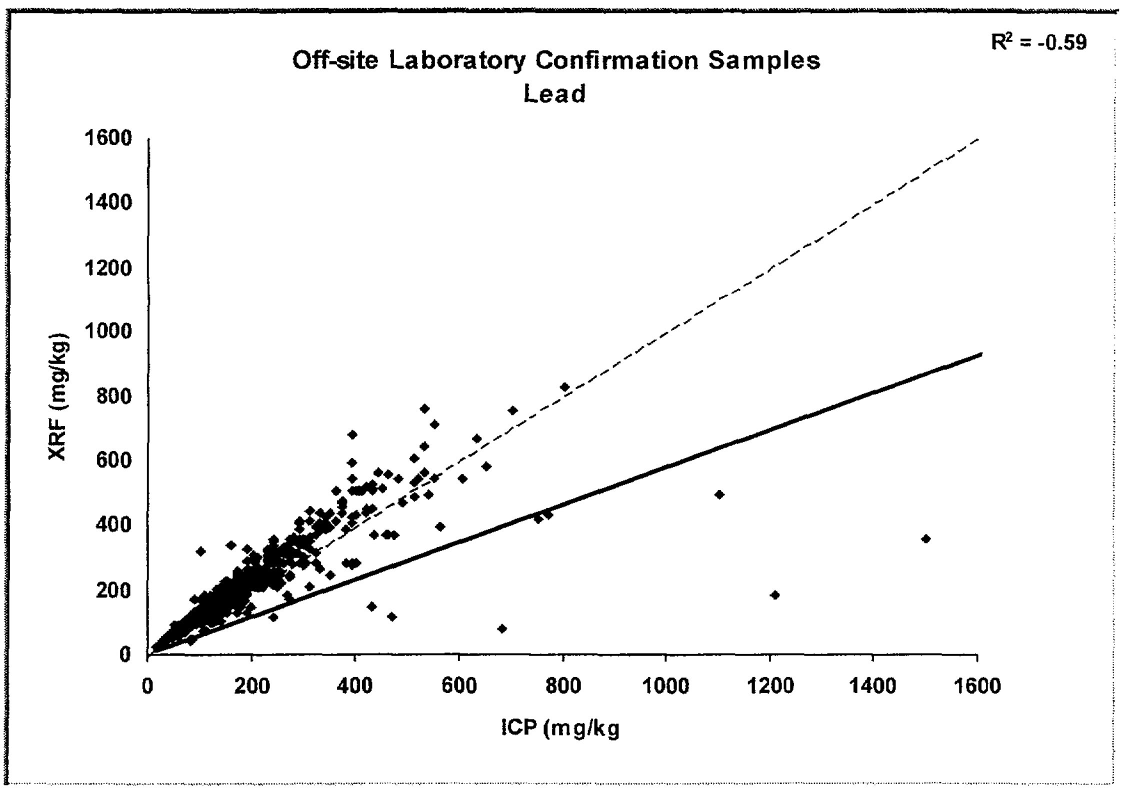
Method Blanks
Arsenic
Concentration (mg/kg)
0
1
2
3
4
5
6
7
8
9
12/6
1/25
3/15
5/4
6/23
8/12
10/1
Date



Method Blanks
Lead
Concentration (mg/kg)
0
5
10
15
20
25
30
35
40
45
50
12/6
1/25
3/15
5/4
6/23
8/12
10/1
Date

Figure 21





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APPENDIX A6

Data Quality Assessment
Phase IIIB Grab Sampling Program

DATA QUALITY ASSESSMENT
PHASE IIIB GRAB SAMPLING PROGRAM

VASQUEZ BOULEVARD AND I-70 REMEDIAL INVESTIGATION

February 9, 2001

Prepared for

U.S. Environmental Protection Agency
Region VIII

Washington
Federal Projects Division

Washington Group International, Inc.
10822 West Toller Drive
Littleton, Colorado 80127

Response Action Contract No. 68-W7-0039
Work Assignment 004-RICO-089R

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1.0 OVERVIEW

Chemical analysis of the Vasquez Boulevard/Interstate 70 (VB/I-70) Phase IIIB grab soil samples was conducted under a comprehensive quality assurance program. The program included requirements for the collection, preparation, and analysis of quality control samples, as specified in the Project Plan for the Vasquez Boulevard & I-70 Site, Phase III Field Investigation (ISSI, 08/04/99), Section 4.0 Quality Assurance Project Plan (QAPP), and related Standard Operating Procedures for sample collection, preparation and analysis.

An assessment of the data quality was performed daily throughout the program to verify compliance with the quality control criteria and to identify necessary corrective actions. An assessment of the grab sample data has been performed to verify that the data set is consistent with and meets the data quality objectives identified in the QAPP. The data quality assessment is presented in terms of the precision, accuracy, representativeness, comparability, and completeness of the data. The results document that the data are usable for their intended purpose of identifying the range of soil concentrations at selected properties and supporting the Baseline Risk Assessment.

2.0 SOIL SAMPLE DATA QUALITY

Soil samples were collected from each of 119 residential yards, 5 schools, and 6 parks. Thirty or fifteen grab samples were collected at each property depending on the size of the samplable area. All soil samples were prepared in the field laboratory by homogenizing the sample, drying a portion of the sample, sieving the sample through a #10 sieve, and then grinding a portion of the sieved, bulk fraction. The ground sample was analyzed at the field laboratory using a QuanX Energy Dispersive X-Ray Fluorescence Spectrometer (XRF). A percentage of samples were split and also submitted for off-site laboratory analysis.

Quality control sample results for soils analyzed by XRF are charted in Figures 1 through 22. Table 1 summarizes the number of soil field samples and each type of quality control sample.

2.1 Precision

Precision measures the reproducibility of values under a given set of conditions. Precision was measured in Phase IIIB soils through preparation and analysis of laboratory duplicates and blind split samples.

2.1.1 Laboratory Duplicates

Laboratory duplicates were prepared and analyzed at a frequency of one for every twenty field samples. Laboratory duplicates were identifiable to the analyst so that the duplicate and original field sample results could be reviewed immediately following analysis. The results of the laboratory duplicates are presented in Figures 1 through 4. Duplicates met the quality control criteria of less than 25% relative percent difference between the original sample and its duplicate, or less than one method detection limit (MDL) for samples with concentrations less than five times the MDL, in all but six samples for arsenic and one sample for lead. The results for samples associated with the preparation of these seven duplicates exceeding the precision criteria were qualified as estimated. Overall correlation of original samples versus duplicates was very good.

2.1.2 Blind Splits

Blind split samples were prepared at the same frequency and in the same manner as laboratory duplicates, but were assigned a unique sample identification number and submitted blind to the analyst such that it could not be distinguished from other field samples. The results of the blind splits are presented in Figures 5 through 8. Blind splits met the quality control criteria of less than 25% relative percent difference between the original sample and its split, or less than one MDL for samples with concentrations less than five times the MDL, in all but twelve samples for arsenic and one sample for lead. The results for samples associated with the preparation of these thirteen blind splits exceeding the precision criteria were qualified as estimated. Overall correlation of original samples versus blind splits was very good.

2.2 Accuracy

Accuracy measures the bias from the true value in a measurement system. Analytical accuracy was evaluated in soils through determination of the arsenic and lead MDLs, instrument calibration using certified standard reference materials (SRM), and analysis of blind standards.

2.2.1 Method Detection Limit Study

The MDL is the lowest concentration of a substance that can be measured and reported with a 99% confidence that the analyte is present. Instrument- and matrix-specific MDLs were determined during Phase IIIA for arsenic and lead. The final Phase III MDLs were calculated as three times the pooled variance of the MDL test results. Instrument sensitivity was verified during Phase IIIB with analysis of seven aliquots each of nine samples. The Practical Quantitation Limit (PQL) is the lowest concentration that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operating conditions. The PQLs for arsenic and lead were calculated as ten times the pooled variance of the MDL test results. Values reported between the MDL and PQL are considered estimated concentrations.

Analyte	MDL (mg/kg)	PQL (mg/kg)
Arsenic	11	36
Lead	52	173

2.2.2 Instrument Calibration

Analytical accuracy was achieved through XRF instrument calibration and re-standardization, supplemented with:

- Daily energy calibration check
- Daily initial calibration verification through analysis of three or more SRMs with certified concentrations provided by the National Institute of Standards and Technology (NIST)
- Continuing calibration verification by analysis of one SRM with each analytical batch

The NIST SRM results are presented in Figures 9 through 14. If a NIST standard exceeded the control limit, then data for samples analyzed with that standard were rejected and the analytical batch was re-analyzed. NIST 2704 was replaced with NIST 8704 (April 2000) before the grab sampling started.

2.2.3 Blind Standards

Accuracy also was measured by submitting blind standards for analysis. These standards were contained and labeled in the same manner as field samples, and therefore the analyst could not identify them as quality control standards. Nominal values for six lots (Lots A - F) were established through multiple analyses of subsamples from the lot. A slightly higher degree of variability is expected for the blind standards as compared to the NIST standards used in the calibration verification because the blind standards prepared for this program did not have certified concentrations and the matrix was more variable. The blind standards results are presented in Figures 15 through 18.

2.3 <u>Representativeness</u>

Representativeness expresses the degree to which sample data accurately and precisely represent a characteristic or condition, and is achieved through proper design of a sampling program.

Representativeness of soil samples has been assessed through preparation and analysis of blanks, comparison of field duplicates, and intra-sample variability tests.

2.3.1 Instrument and Method Blanks

Instrument blanks (Figure 19) consisting of clean sand were run with each analytical batch. Method blanks (Figure 20) consisted of clean sand that was processed through the entire laboratory preparation and analytical procedures on a daily basis. Instrument and method blank results all were below the MDLs and demonstrate that cross contamination did not occur between samples within the field laboratory.

2.3.2 Rinse Blanks

Rinse blanks were prepared by rinsing decontaminated soil sampling equipment (augers, trowels, and bowls) with deionized water and collecting the rinsate for analysis. Rinse blanks were collected at a frequency of 5.7% of the grab samples, which is more than the 5% (one for every twenty field samples) stated in the QAPP. Lead and arsenic results were reported below 0.01 mg/L in all rinse blanks. The results demonstrate overall effective decontamination of soil sampling equipment.

2.4 Comparability

Comparability is a qualitative parameter expressing the confidence with which one data set can be compared to another. Comparability was evaluated during Phase IIIB grab sampling through preparation and analysis of confirmation soil samples.

2.4.1 Confirmation Samples

A percentage of the samples were split and prepared as confirmation samples. One confirmation sample was prepared for every ten field samples. The confirmation samples were submitted to an off-site, fixed laboratory for analysis by EPA Method 6010B, Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP). Results for blind standards submitted along with the confirmation samples are presented in Figures 15 through 18.

A portion of the confirmation sample results were qualified as estimated based on the laboratory's quality control data. However, no major anomalies were identified and no data were rejected. The comparison of XRF versus ICP results are presented in Figure 21. The results exhibit a high degree of correlation, with the exception of 3 out of 355 (0.8%) lead concentrations. When these three ICP lead results were compared to the respective XRF results the RPD was greater than 50%. The correlation coefficient excluding these three outliers is 0.91. The confirmation sample data document that the XRF results are generally comparable to those from ICP analysis.

2.5 Completeness

Completeness is a measure of the percent of useable data generated as compared to the data required and collected. Grab samples were collected from 119 residential properties, which is 100% of all target properties. Useable data were produced for 100% of the samples collected. These achievements are consist with the project completeness goals of sampling 100% of properties granting access, and producing useable data for greater than 90% of the data generated.

3.0 PROPERTY SOIL DISTRIBUTIONAL ANALYSIS

The Data Quality Assessment (DQA) for the grab sample data followed a similar procedure as the DQA for composite samples, with a few modifications. The DQA analyzed grab sample data sets and composite data sets, but the analysis did not compare grabs and composites at unique properties on a property-by-property basis. In general, the results indicated expected differences between the grab sample data set and the composite sample data set due to the higher variability of grab samples.

Grab sample data from 31 properties (approximately 25% of the total data set) were tested for normality using USEPA's Data Quest software. Five tests for normality were applied to each property, and normality was indicated by at least one of the tests for all except two properties. An alternative test, the mean plus three standard deviations, indicated that the sample data for 60% of the grab sample properties could be considered normally distributed. Because the variability of grab samples is greater than for composites, a percentage of the properties would be expected to exhibit non-normal data distributions.

Grab sample data coefficients of variation (CV) were larger for grab samples within a property than for composite samples. For the composite samples, the coefficients of variation were expected and proved to be below 1.0 most of the time (98%). This is also true for the properties with grab samples. However, an increase in the rate of exceedence of 1.0 for the CV is expected with grab samples, due to their higher variability. CVs for grab samples were below 1.0 approximately 80% of the time.

Table 1

PHASE IIIB SOIL SAMPLING ANALYTICAL PROGRAM SUMMARY

SAMPLE TYPE	TOTAL
Grab Samples	3585
Blind Duplicates	180
Lab Duplicates	181
Blind Standards	140
Lab Control Sample (SRM)	639
Instrument Blanks	274
Method Blanks	80
MDL Study Samples	0
Proficiency Samples	0
Variability Test Samples	0
Other Test Samples	48
Off-Site Confirmation Samples	355
Equipment Blanks	203
TOTAL SAMPLES	**5685**

Figure 1
Laboratory Duplicate Results - Arsenic

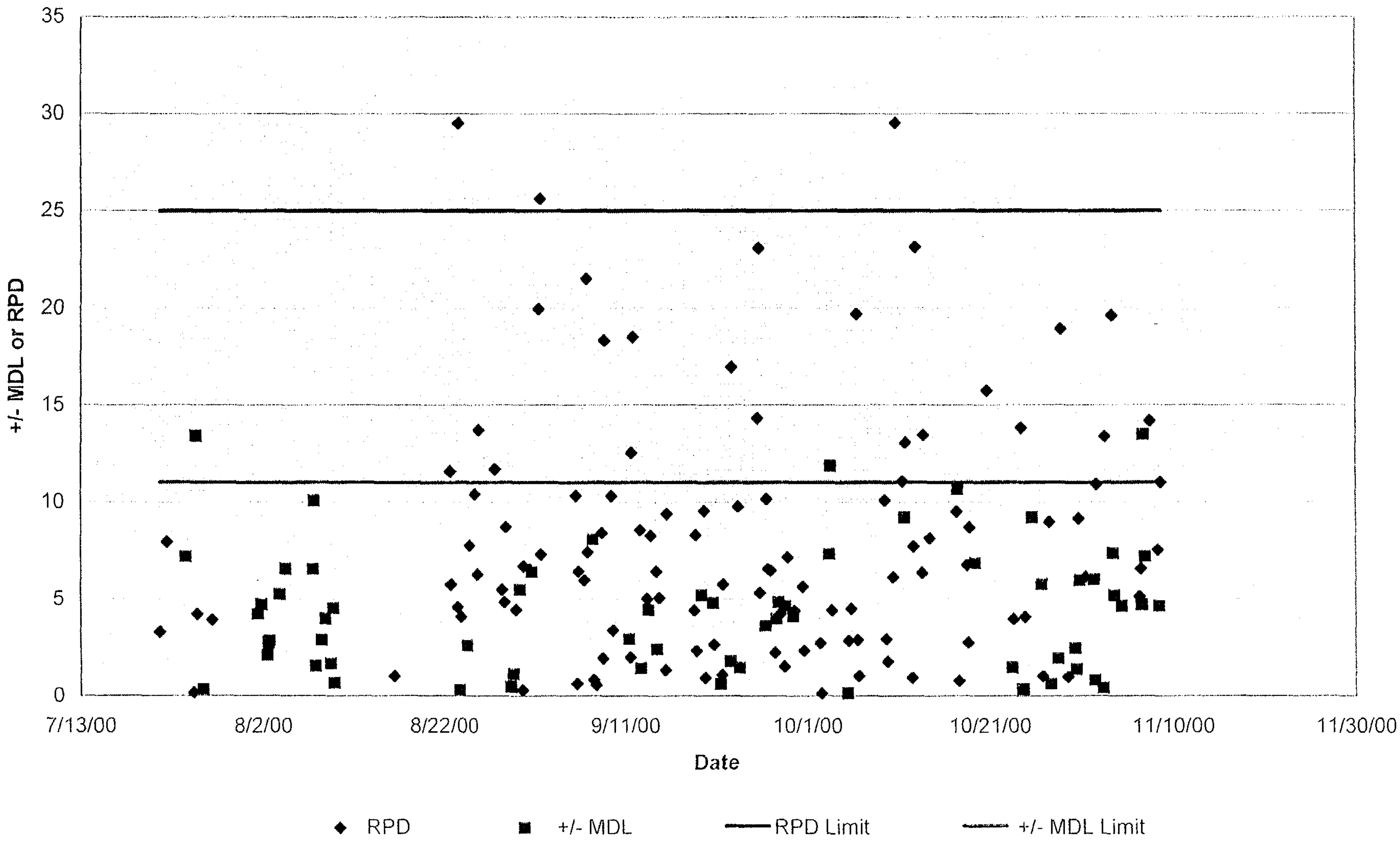


Figure 2
Laboratory Duplicate Results - Lead

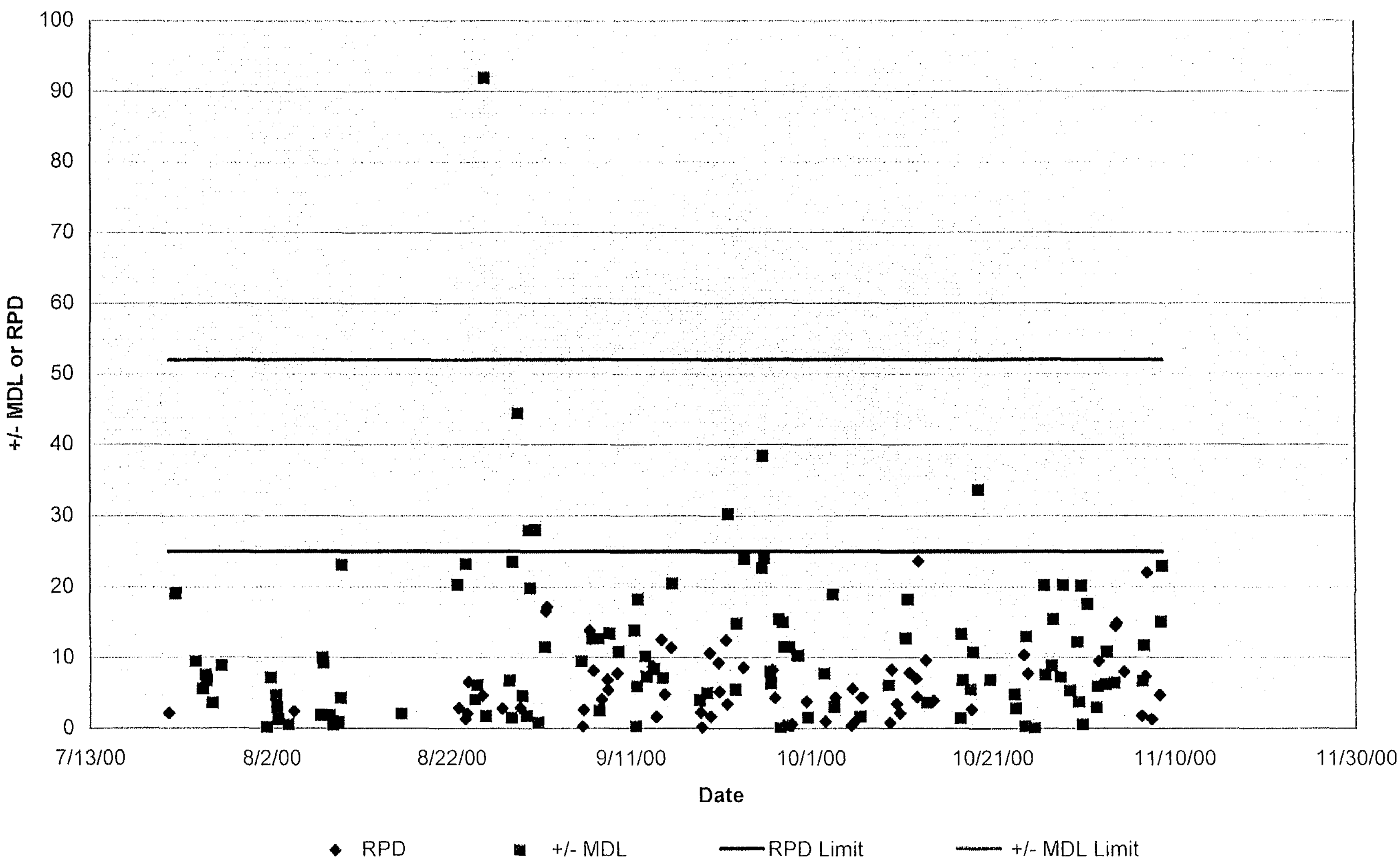


Figure 3
Laboratory Duplicate Correlation - Arsenic

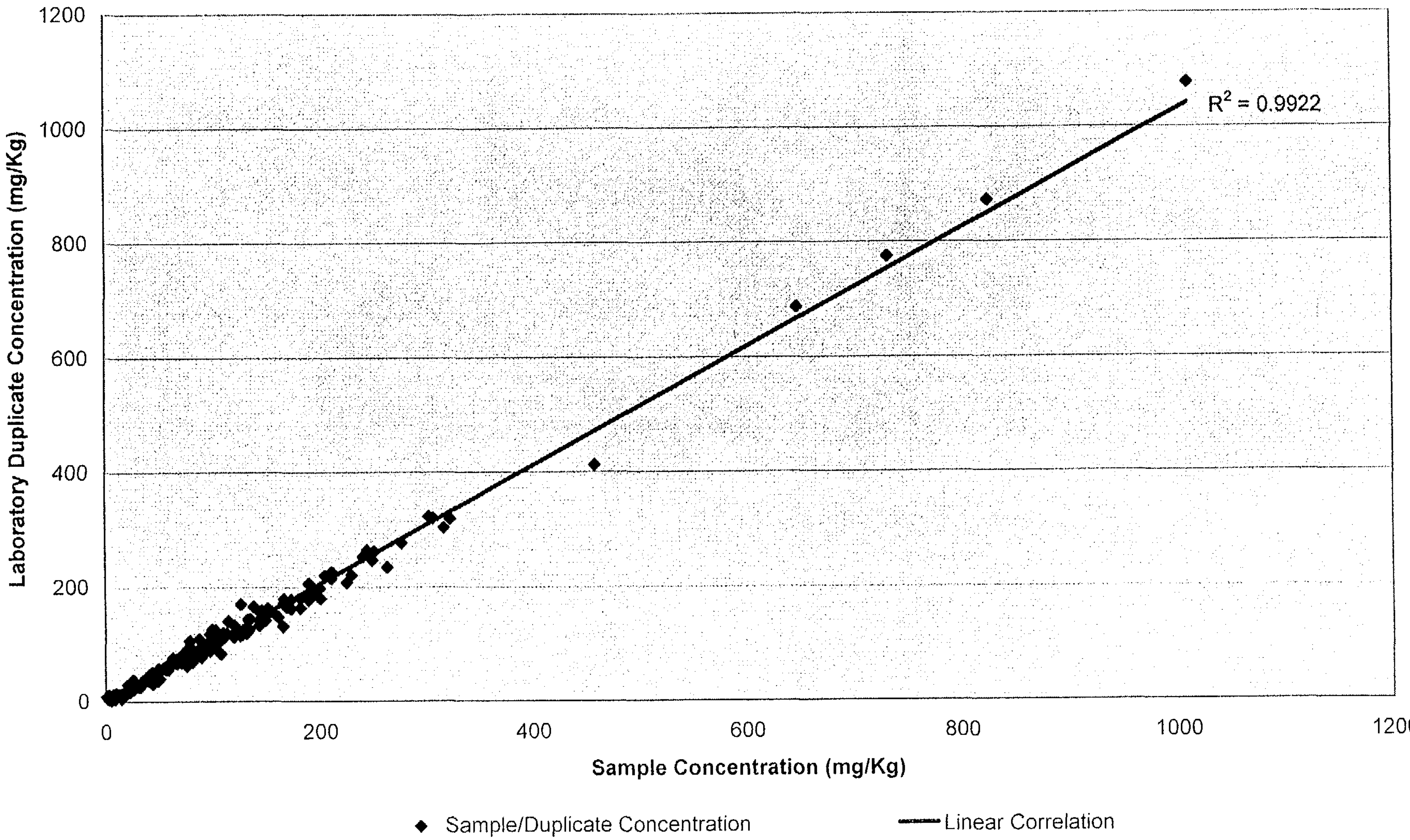


Figure 4
Laboratory Duplicate Correlation - Lead

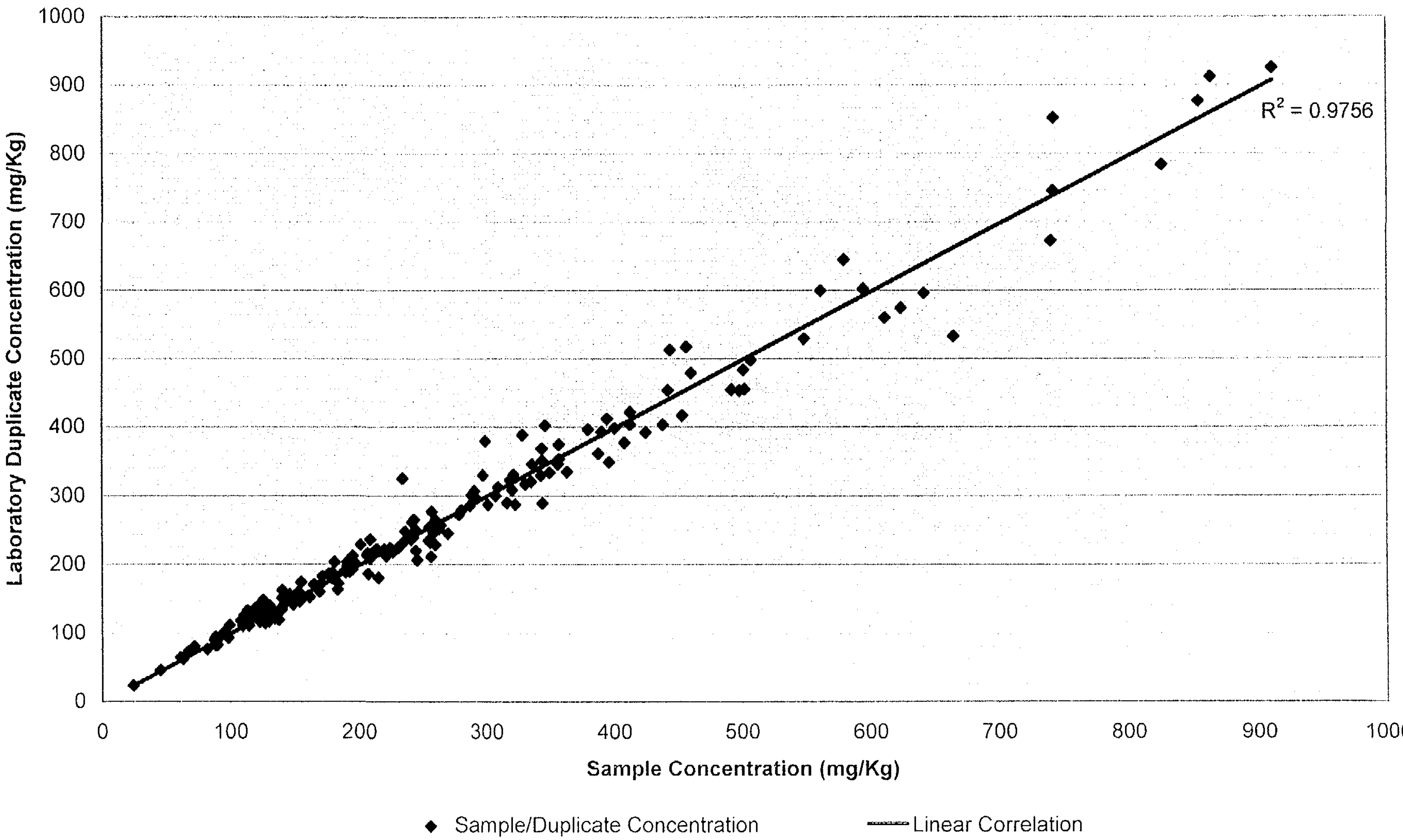


Figure 5
Blind Split Results - Arsenic

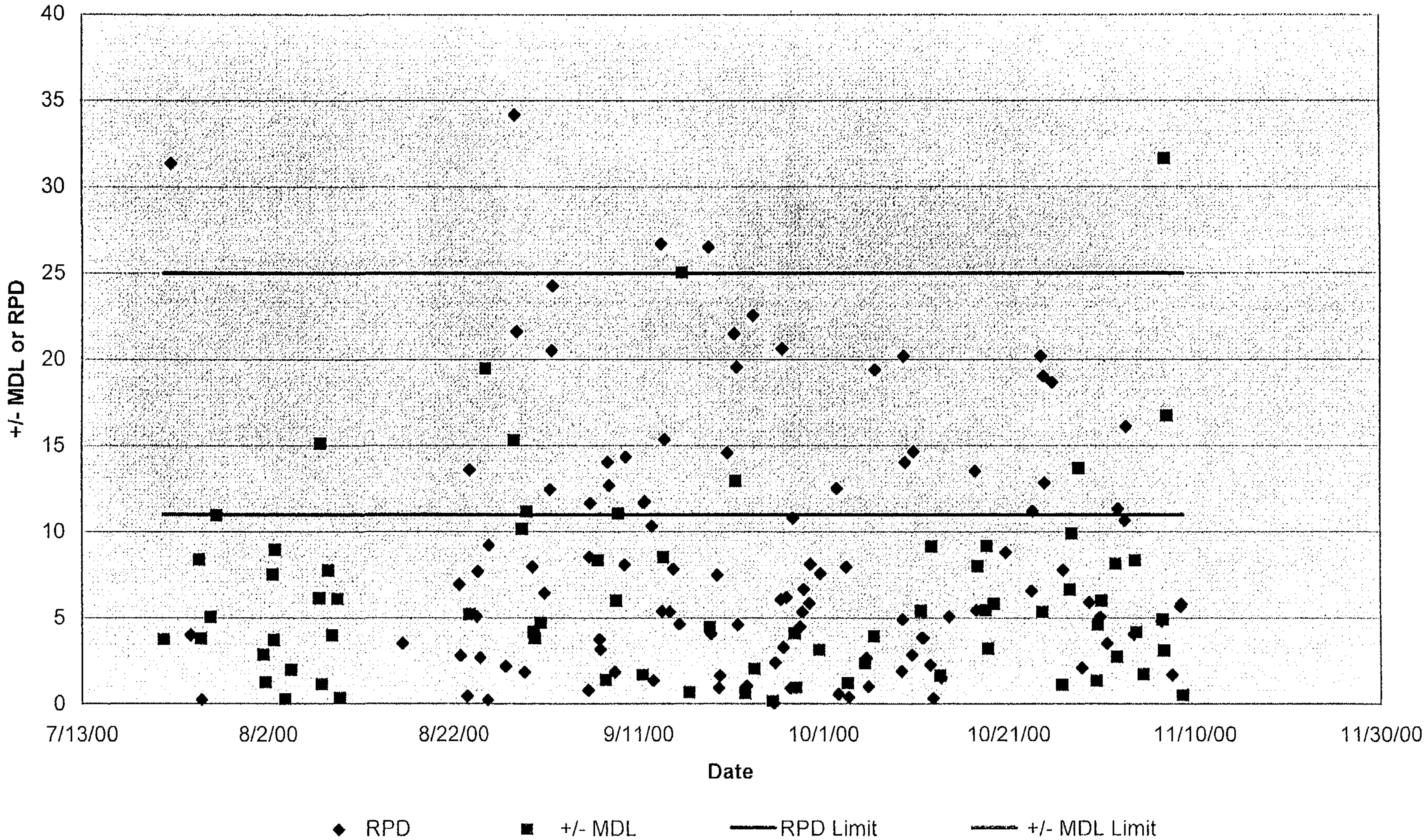


Figure 6
Blind Split Results - Lead

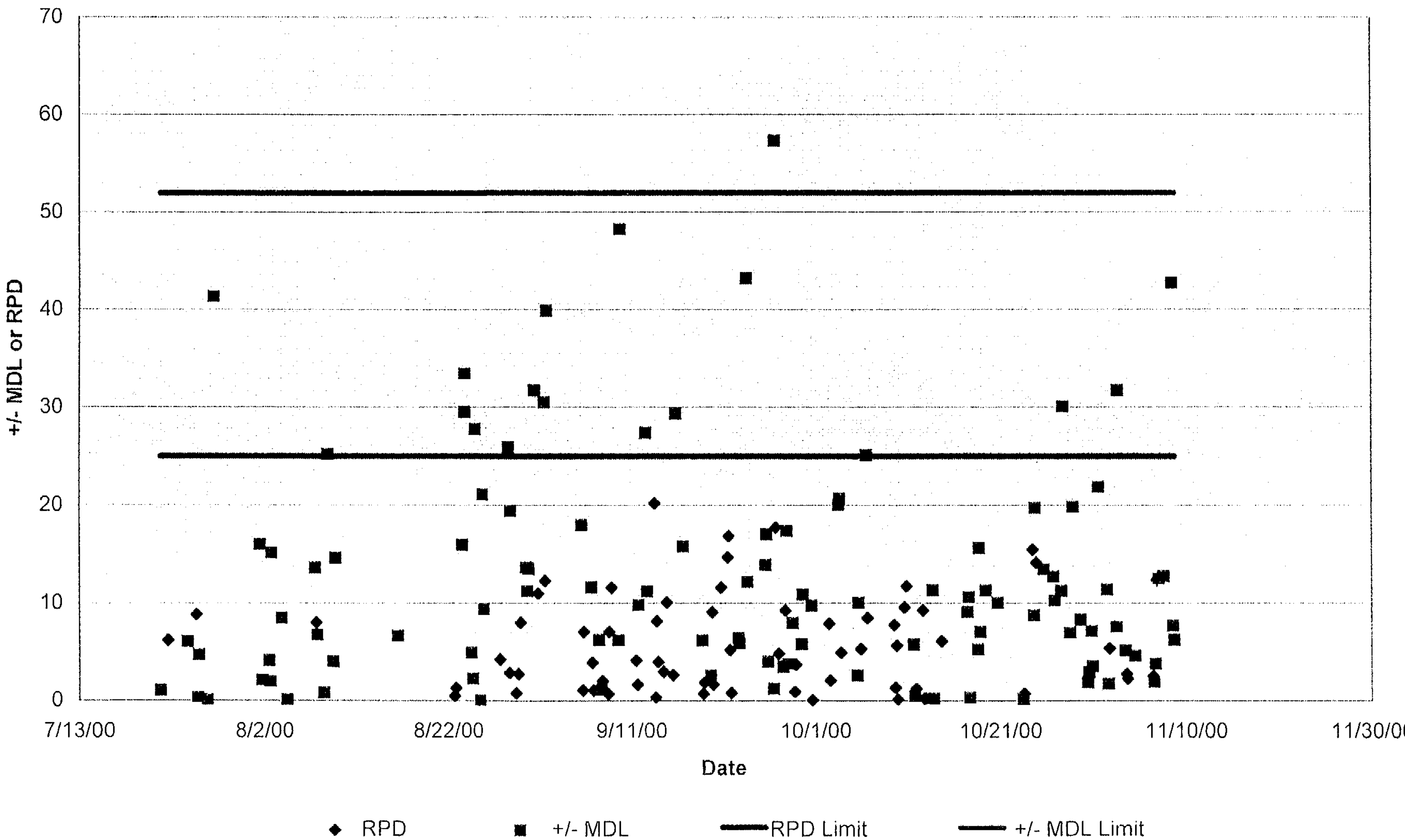


Figure 7
Blind Split Correlation - Arsenic

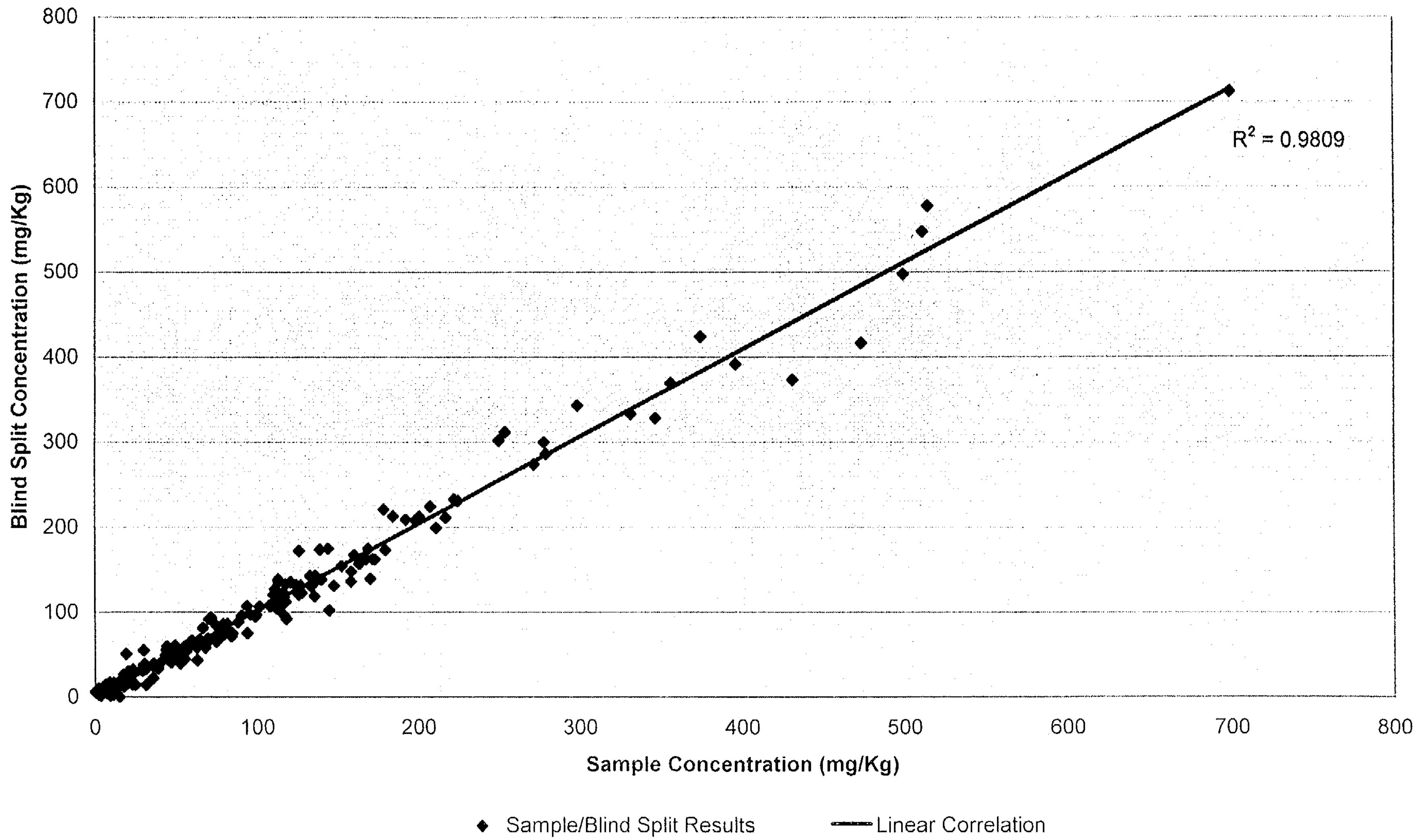
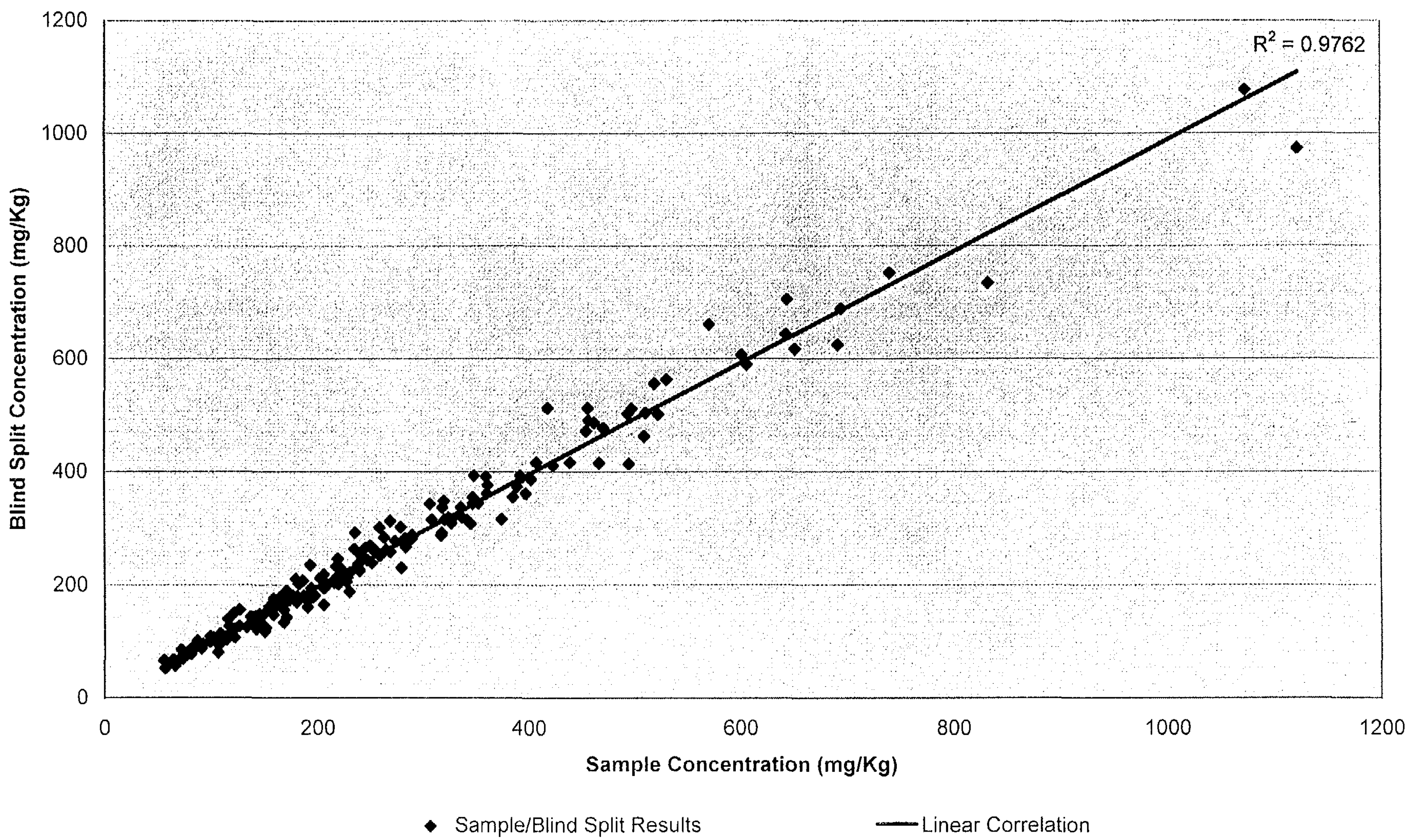


Figure 8
Blind Split Correlation - Lead



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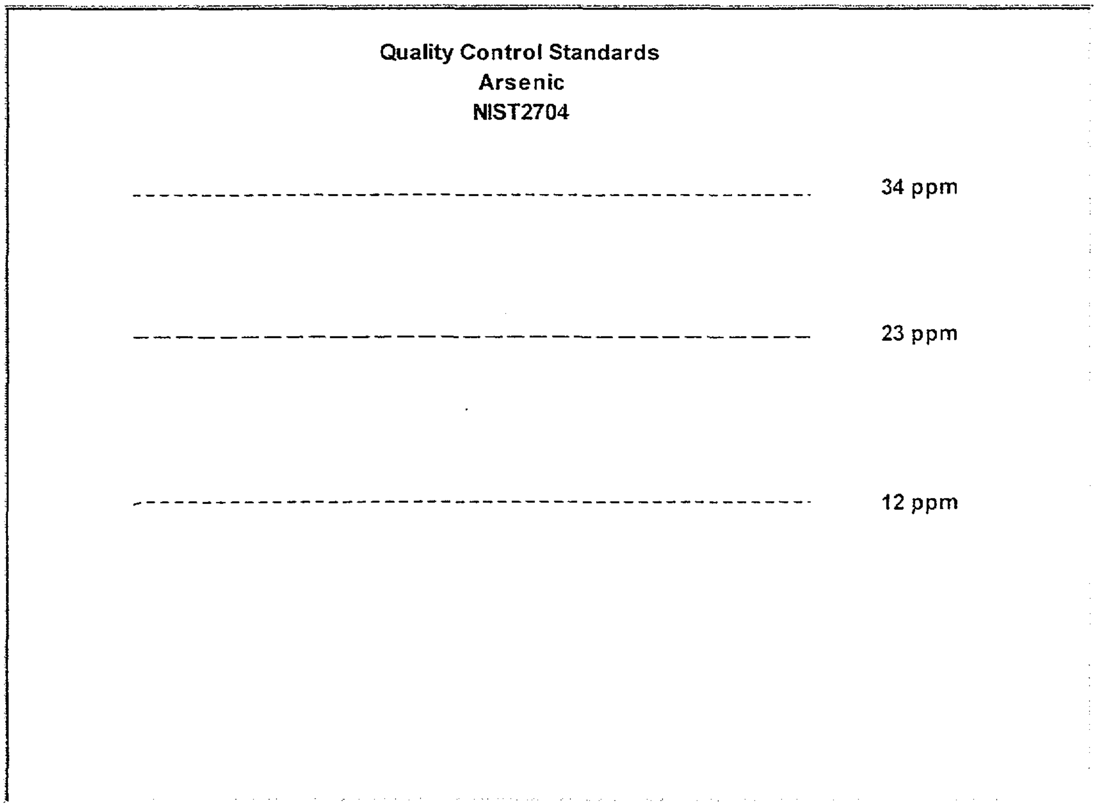

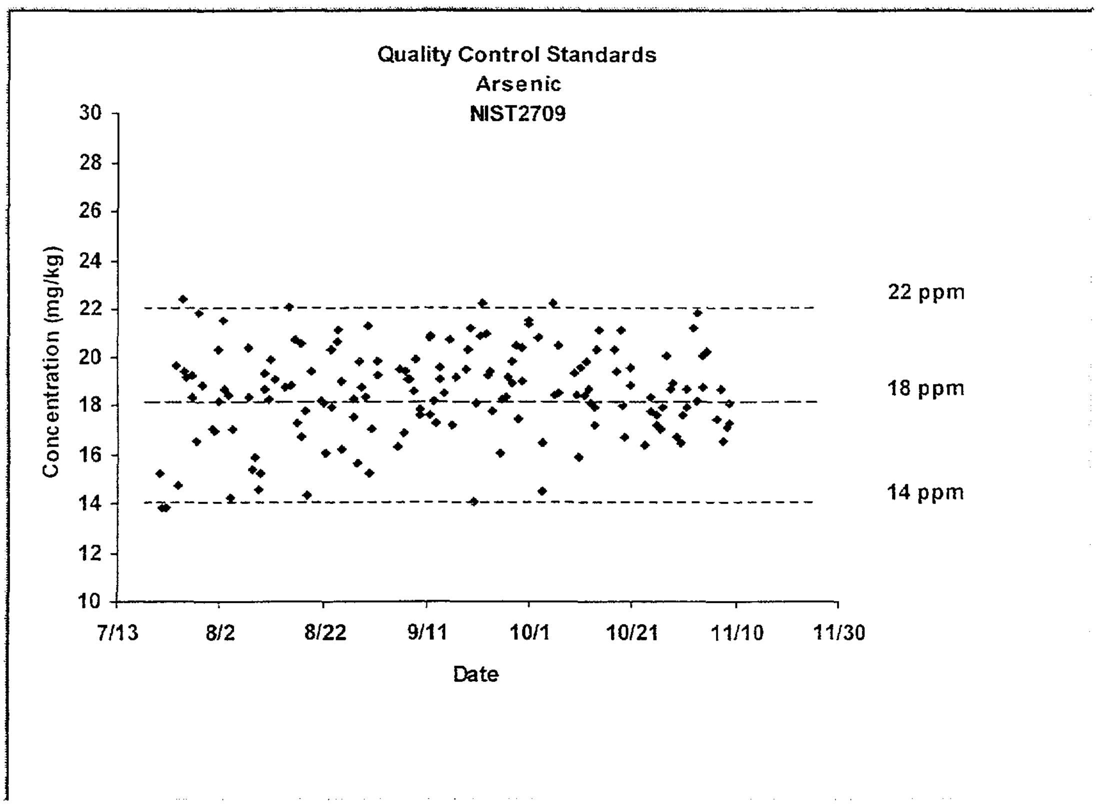

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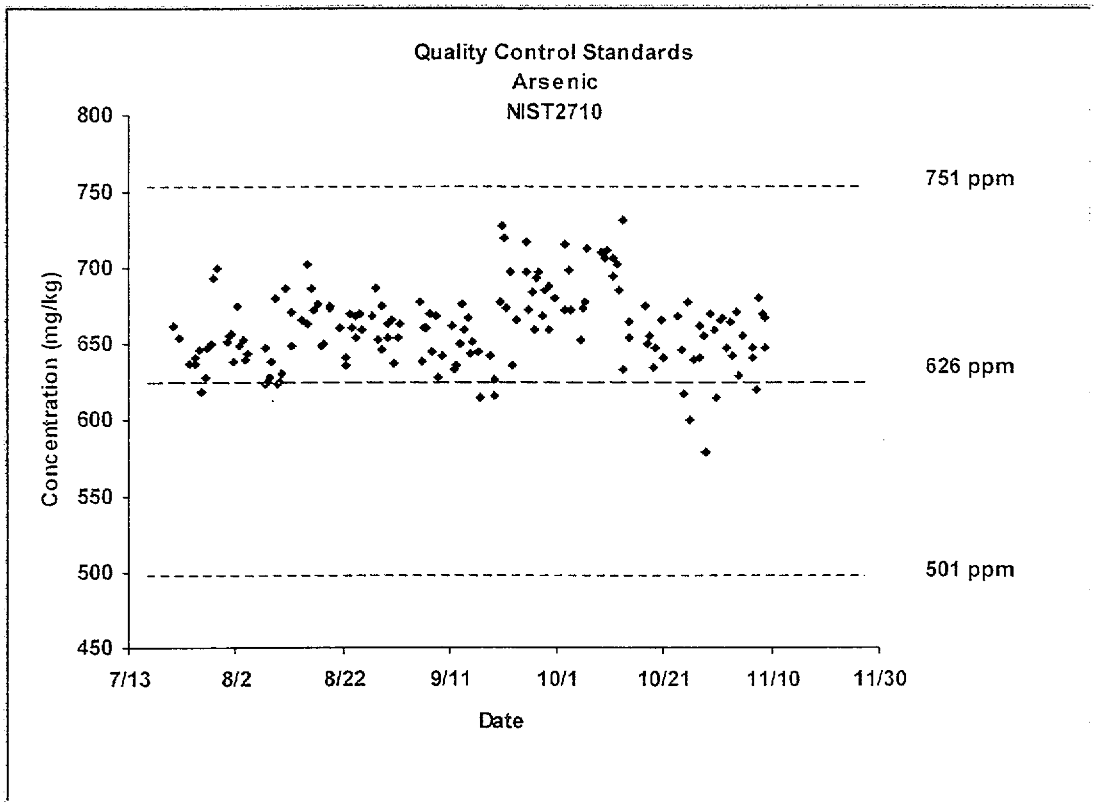

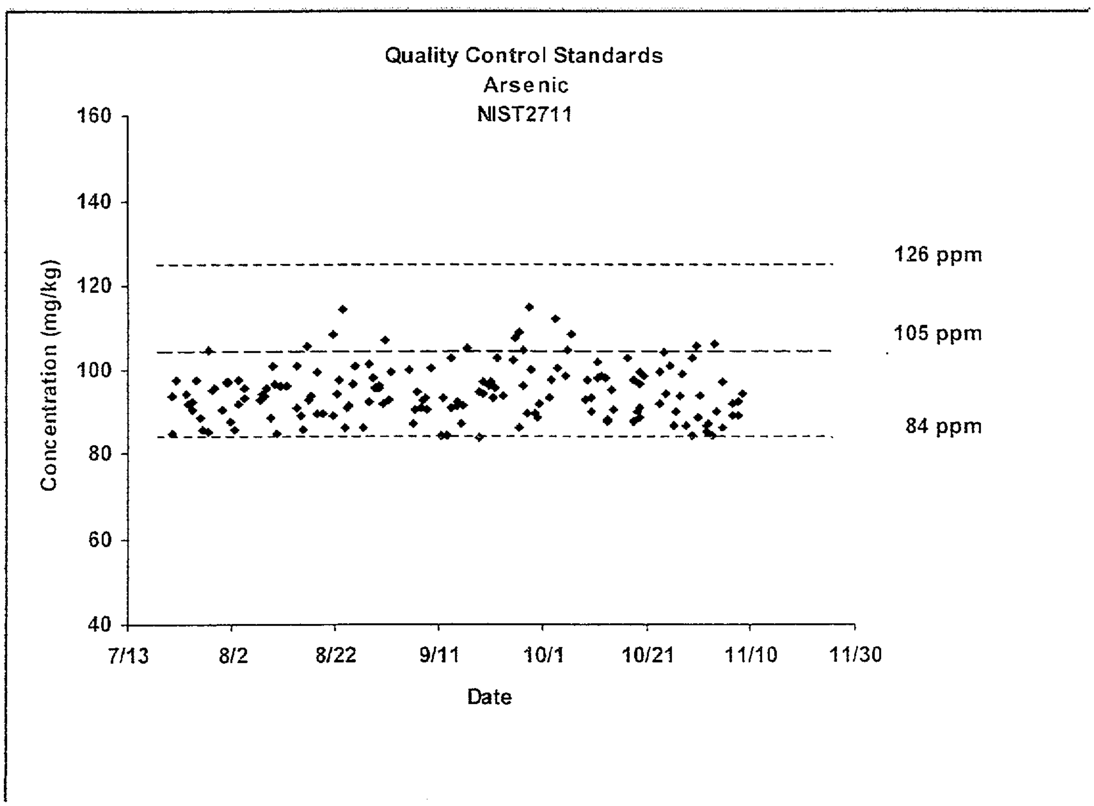

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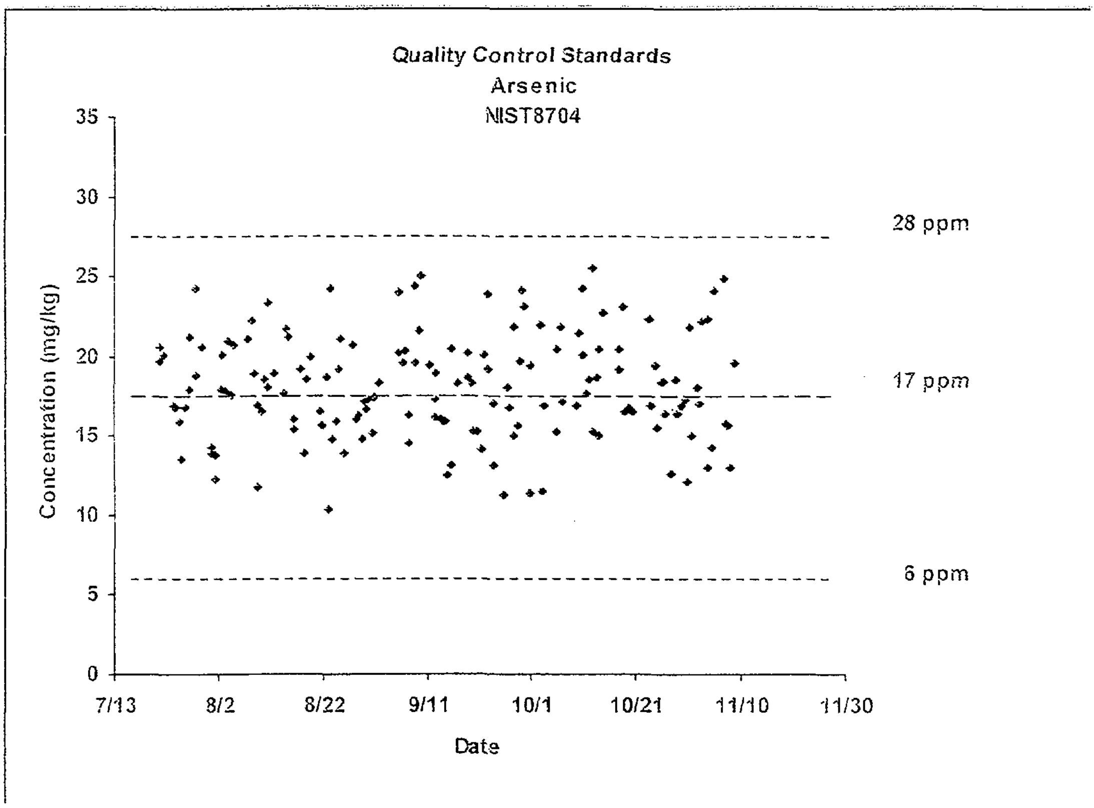
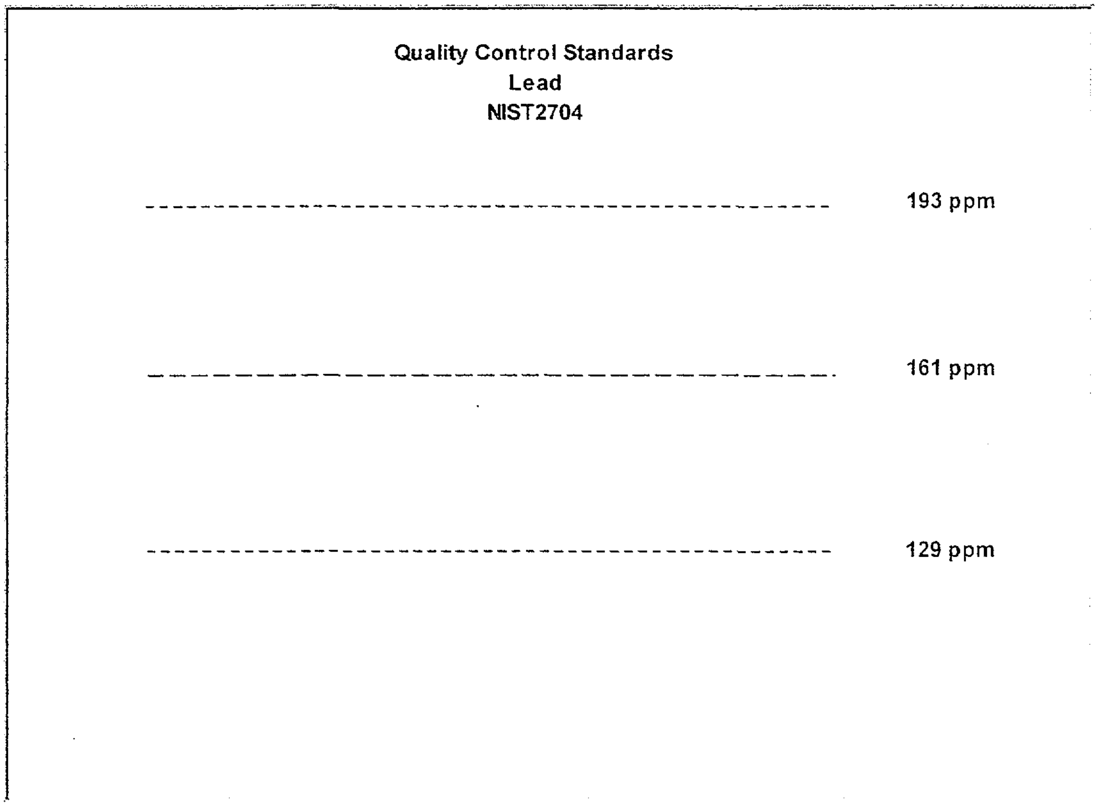
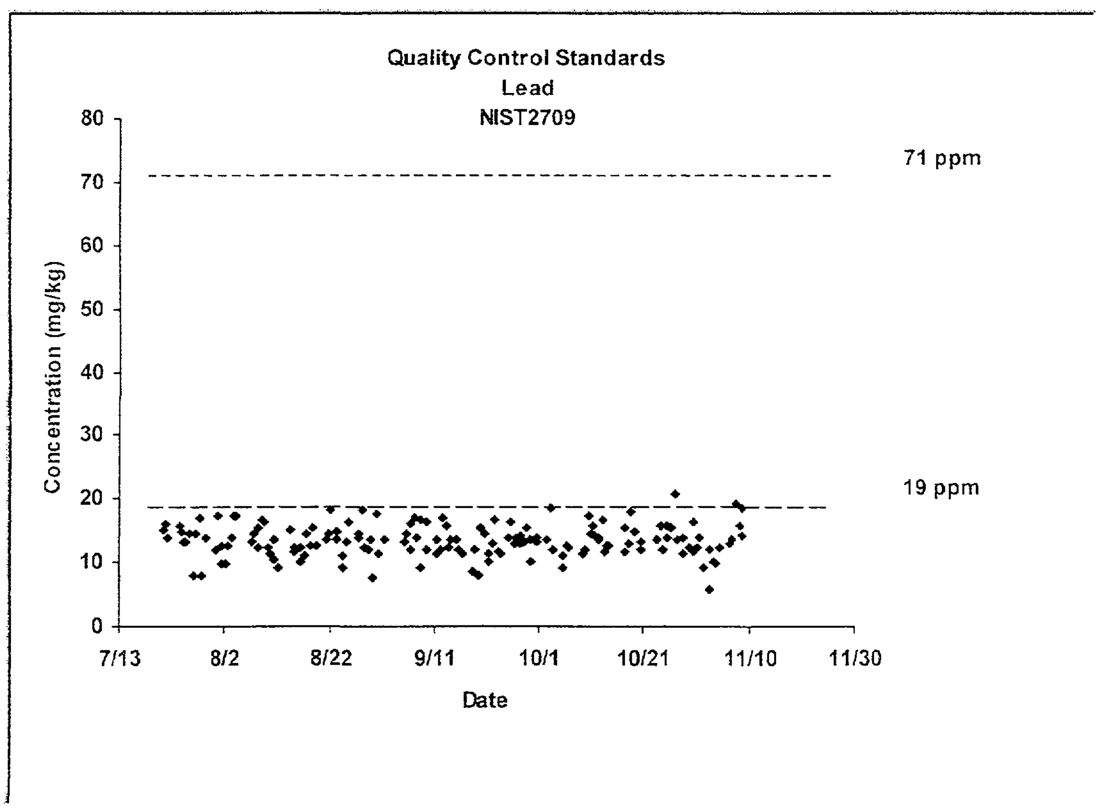
Figure 11



Quality Control Standards
Arsenic
NIST8704
28 ppm
17 ppm
6 ppm
Concentration (mg/kg)
35
30
25
20
15
10
5
0
7/13
8/2
8/22
9/11
10/1
10/21
11/10
11/30
Date

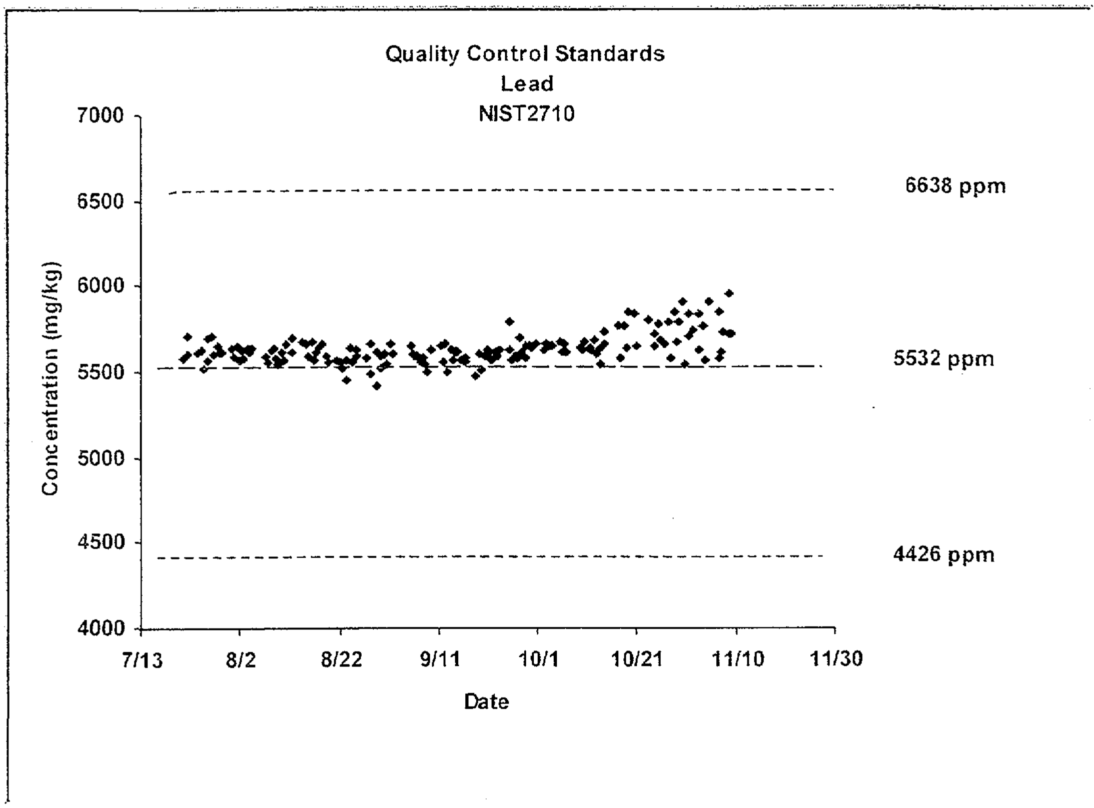
Figure 12

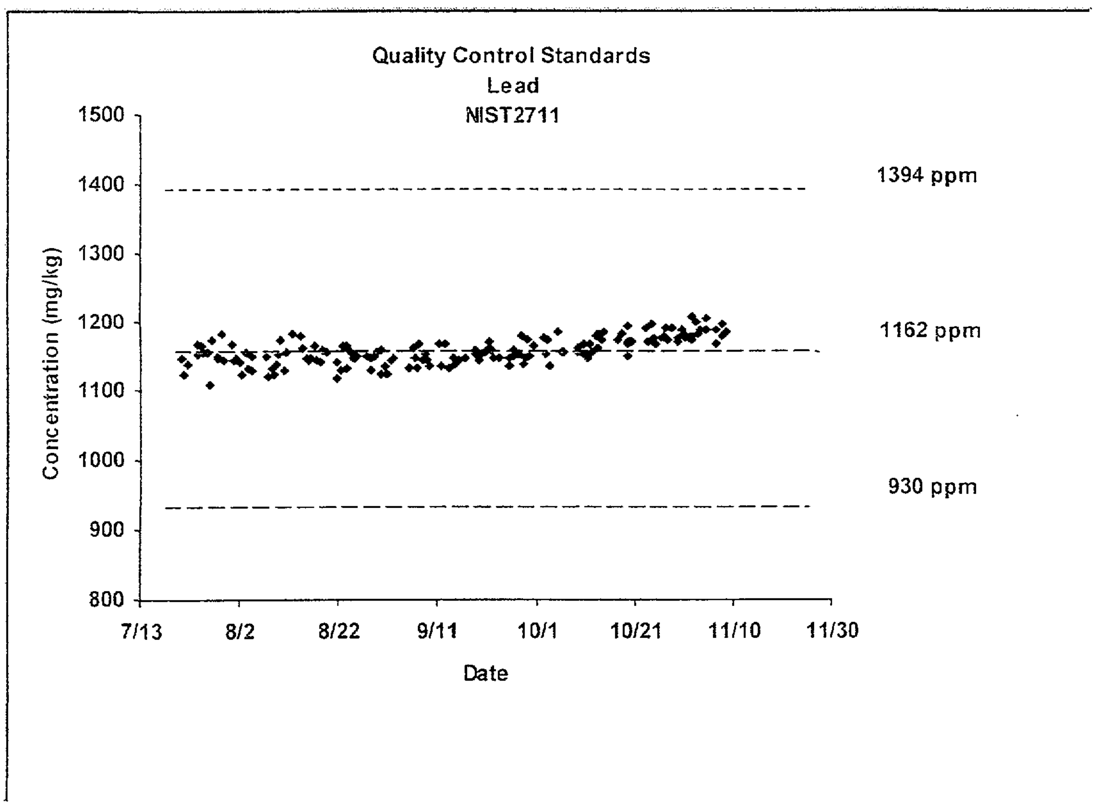




2/2/01 06:51 AM

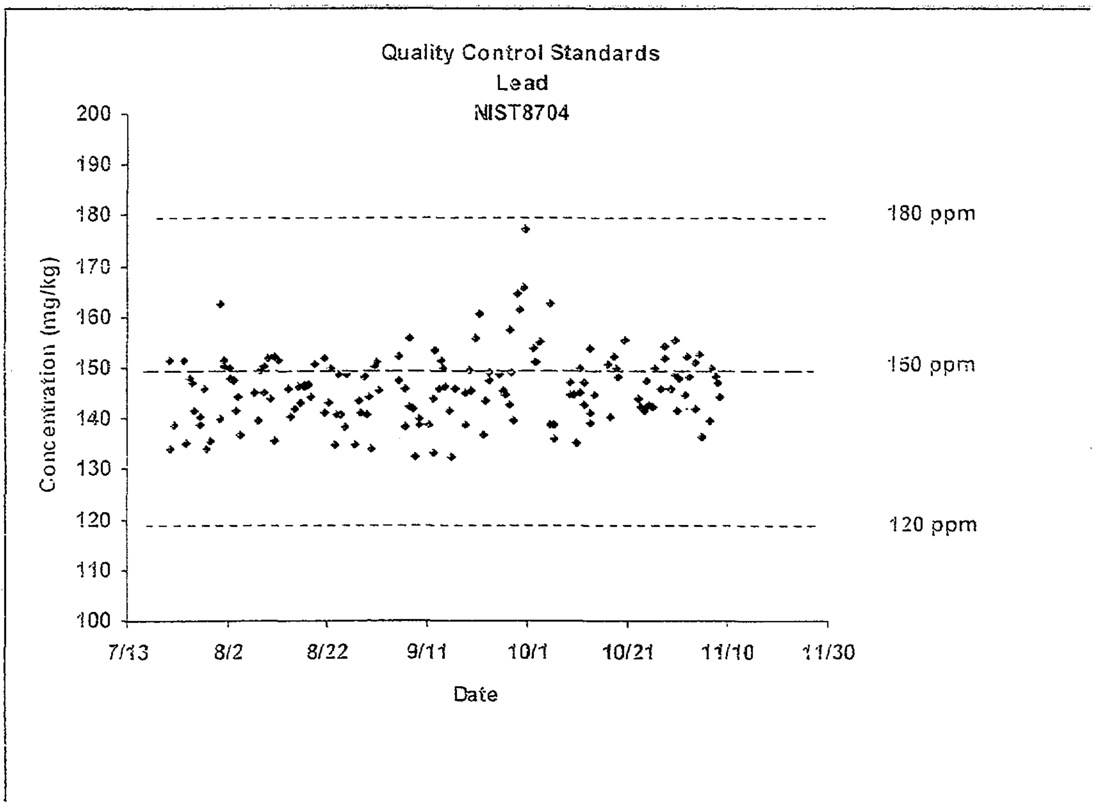
Figure 13





2/2/01 06:51 AM

Figure 14



Quality Control Standards
Lead
NIST8704
200
190
180
170
160
150
140
130
120
110
100
Concentration (mg/kg)
180 ppm
150 ppm
120 ppm
7/13
8/2
8/22
9/11
10/1
10/21
11/10
11/30
Date

Figure 15
Blind Standards A, B, C, and D - Arsenic

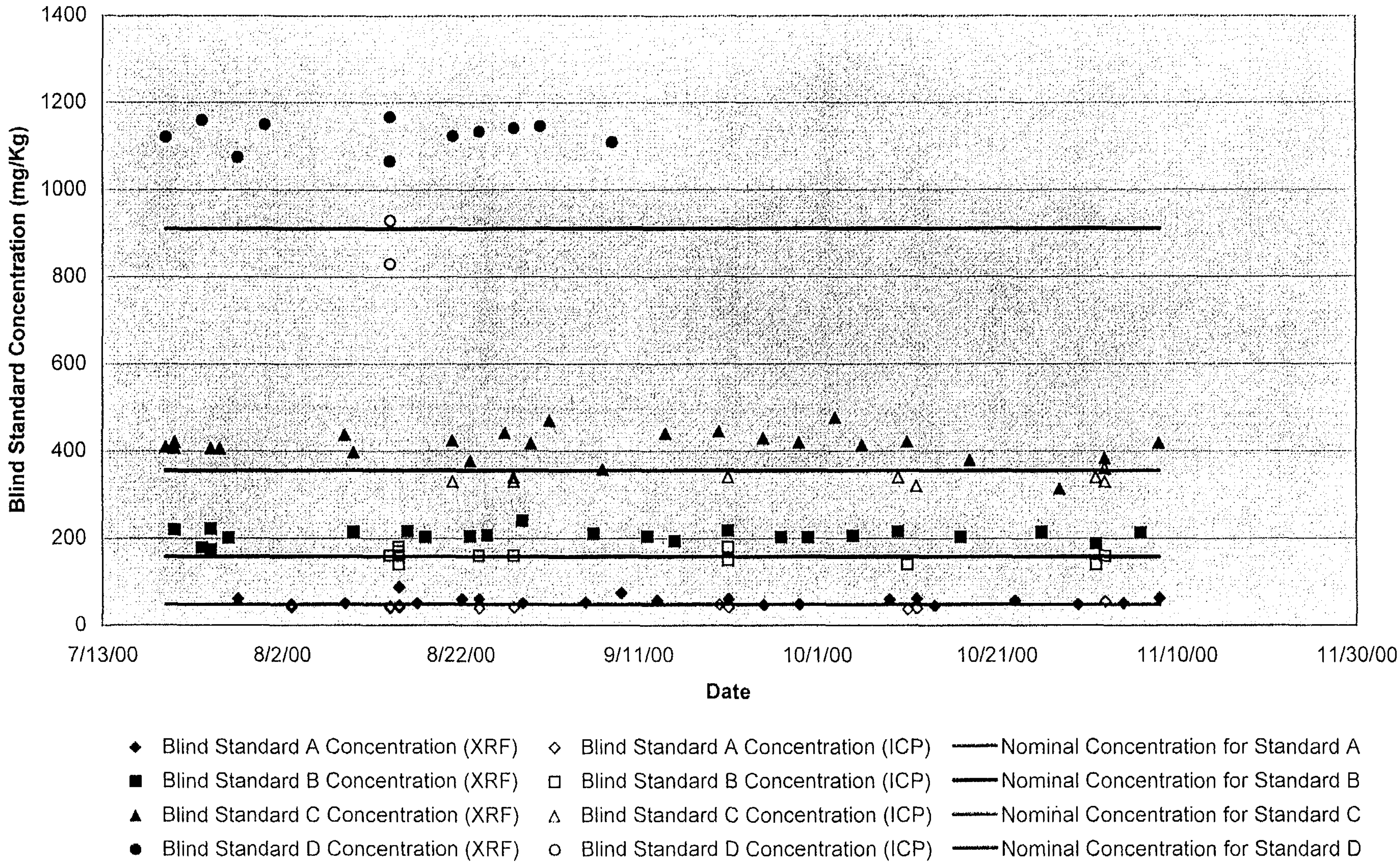


Figure 16
Blind Standards E and F - Arsenic

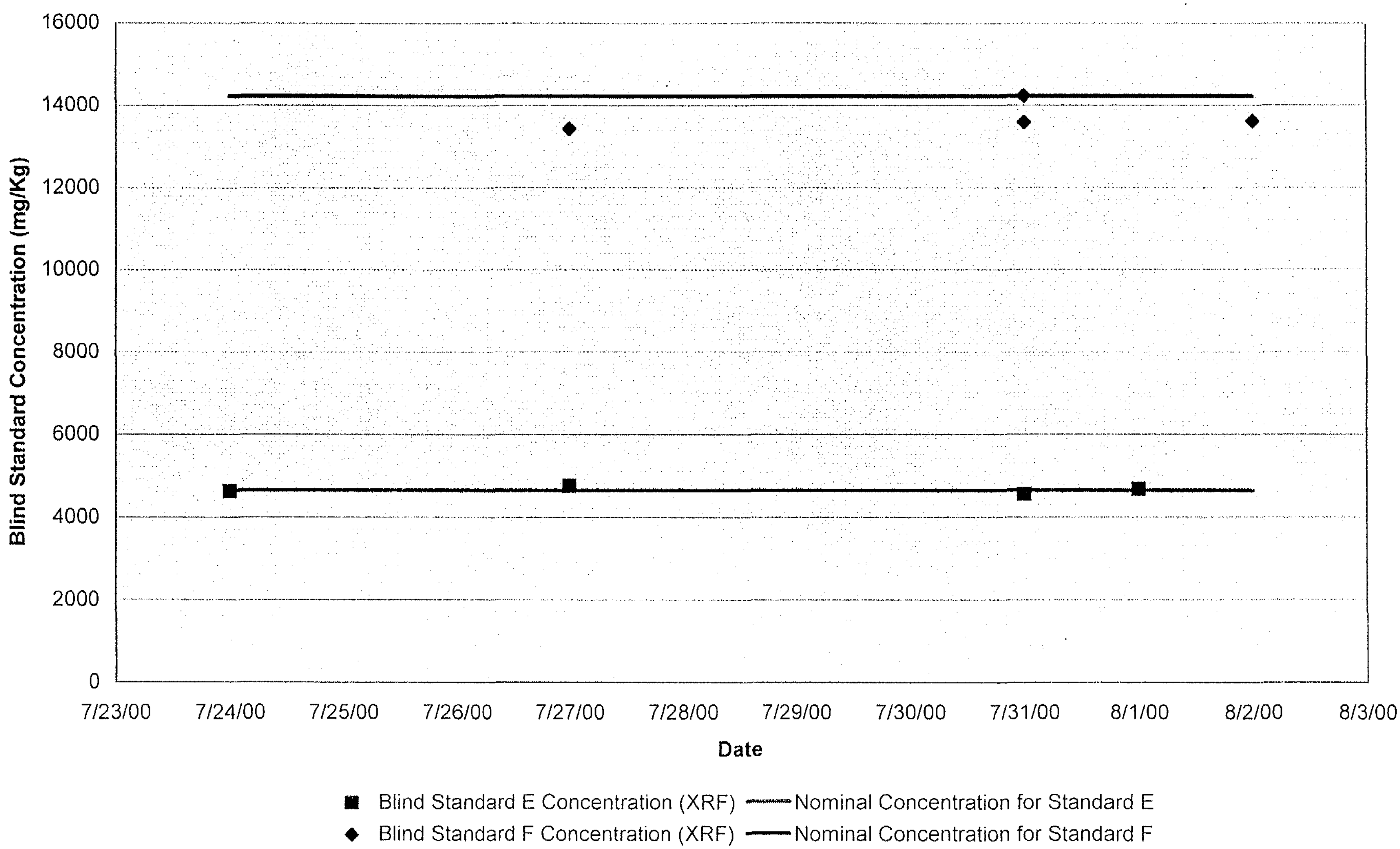


Figure 17
Blind Standards A, B, C, and D - Lead

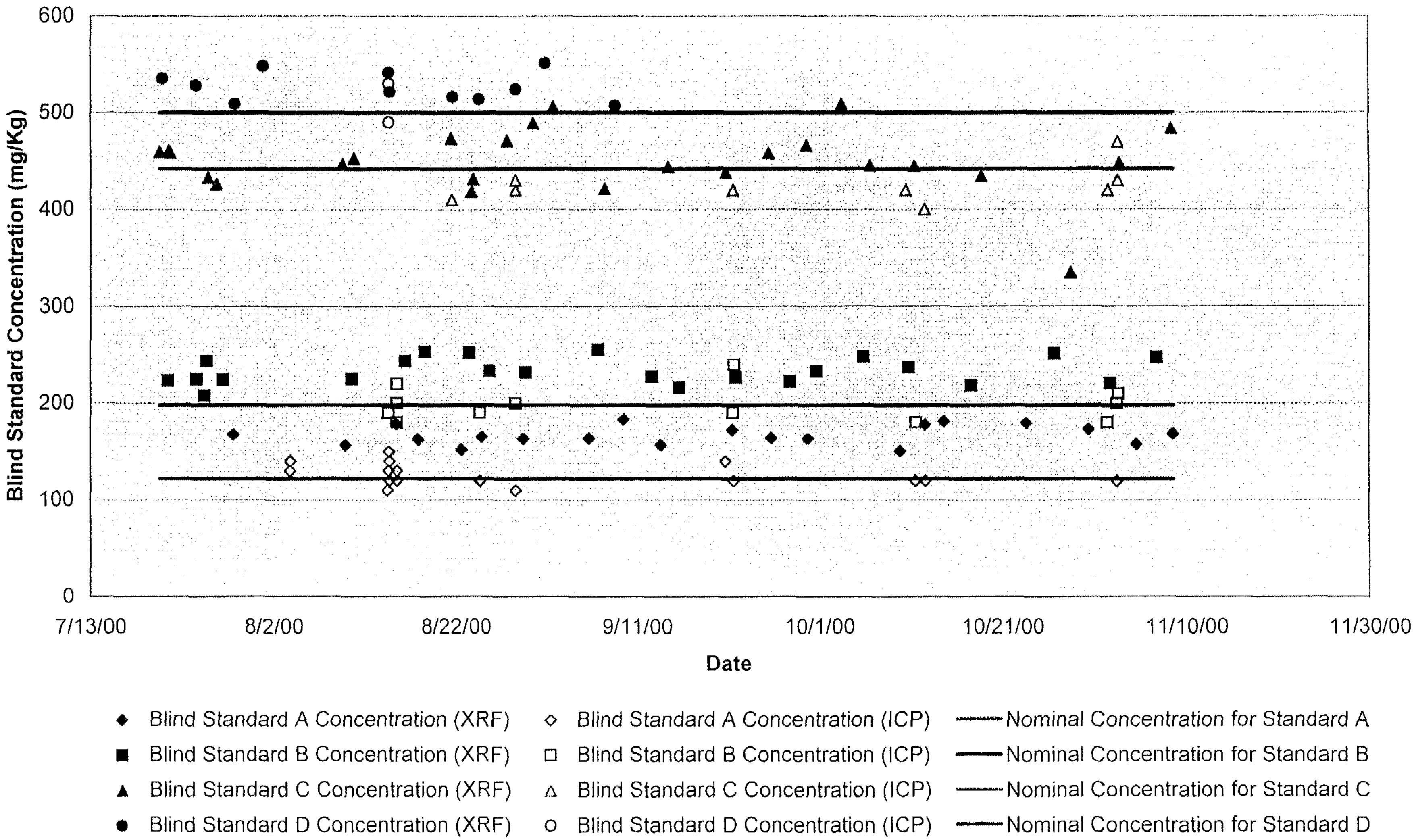


Figure 18
Blind Standards E and F - Lead

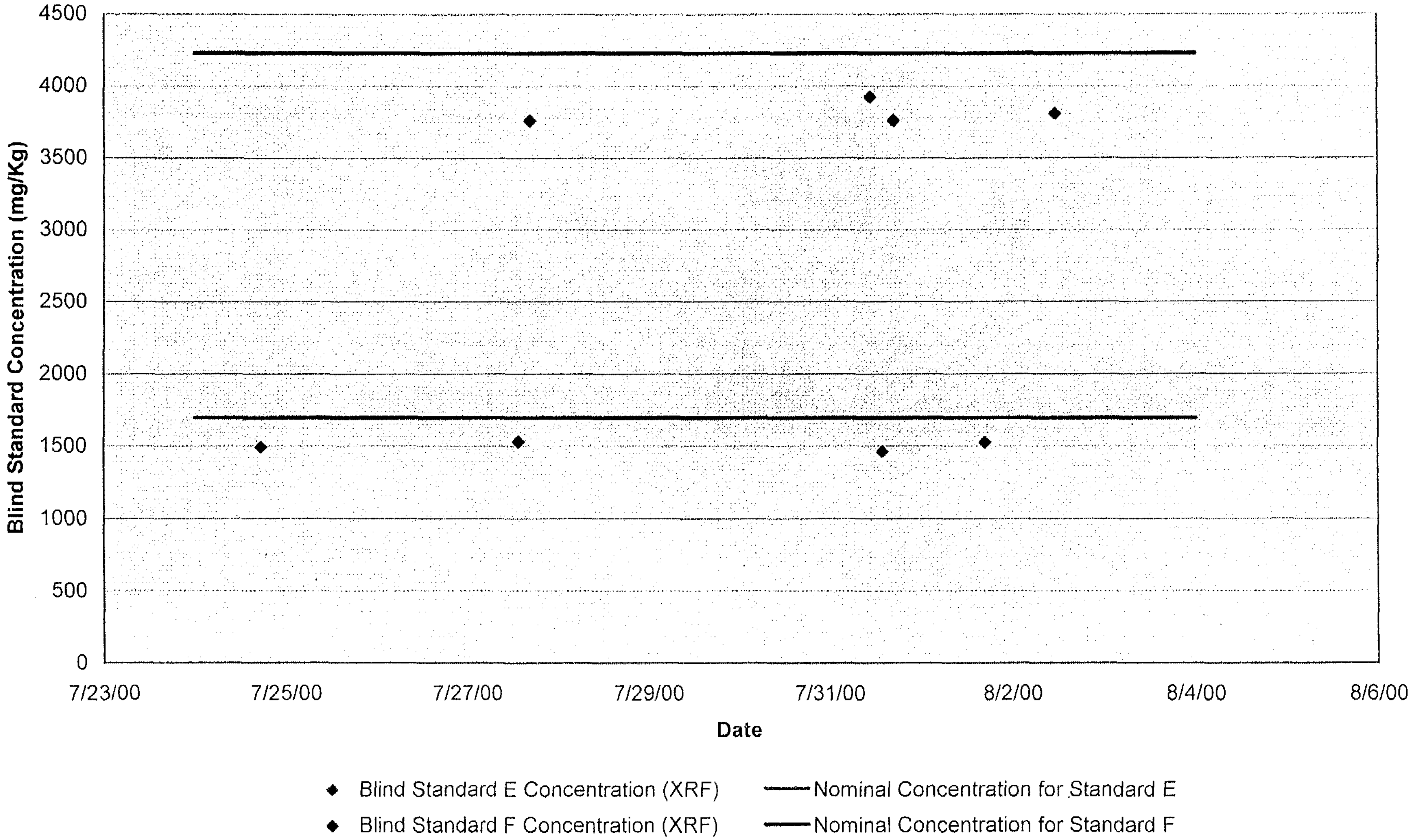
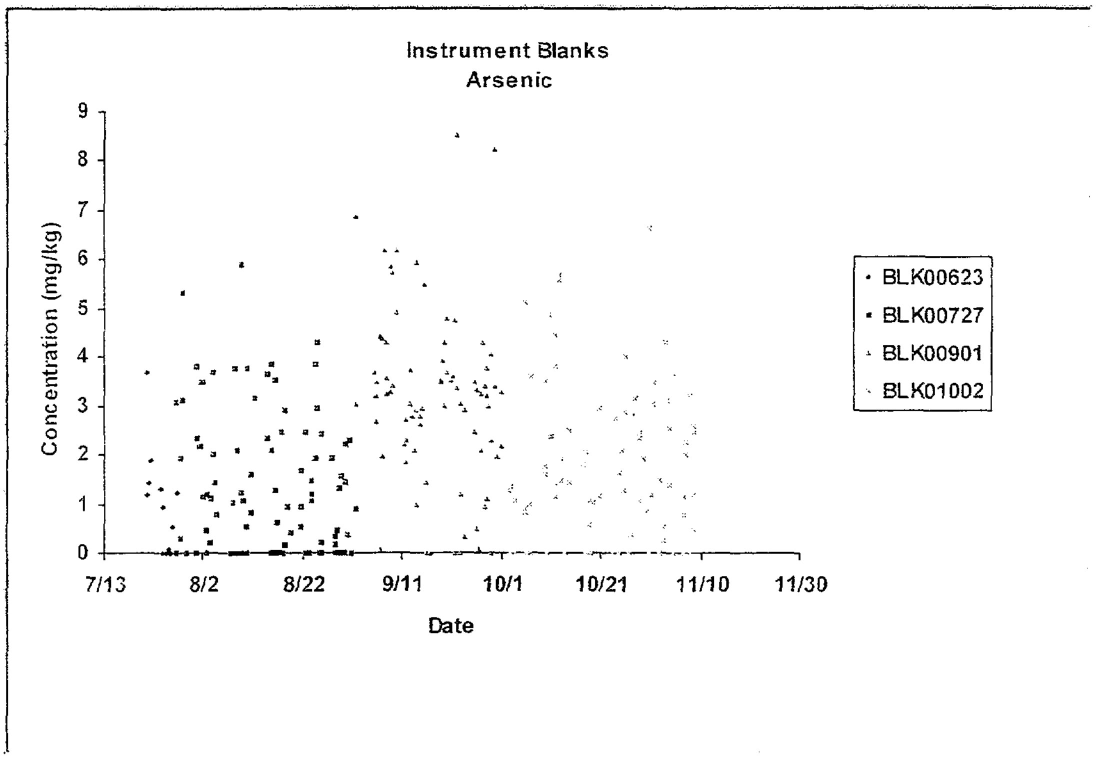
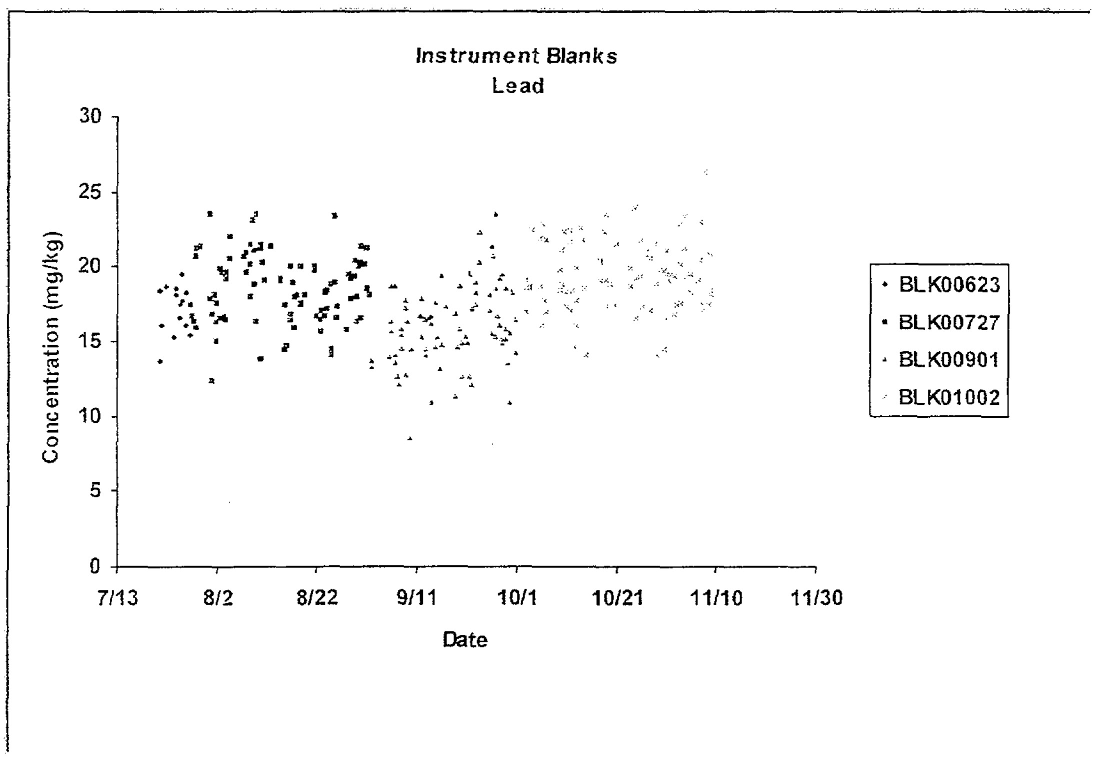


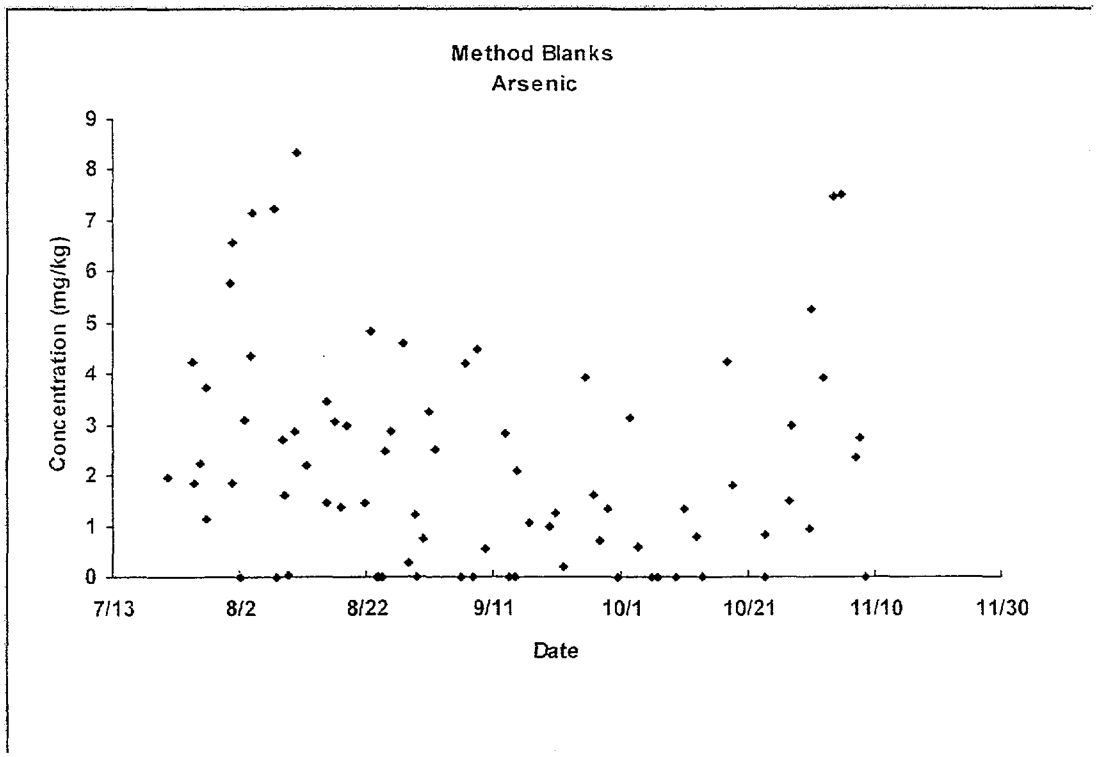
Figure 19

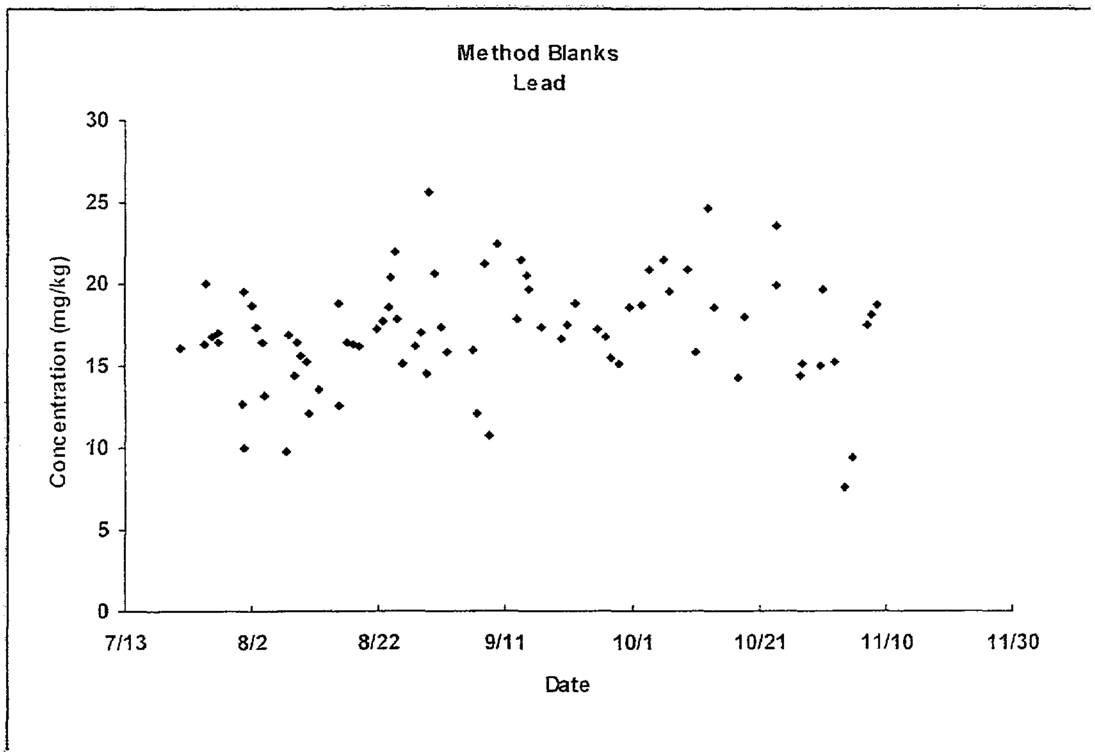




2/2/01 06:51 AM

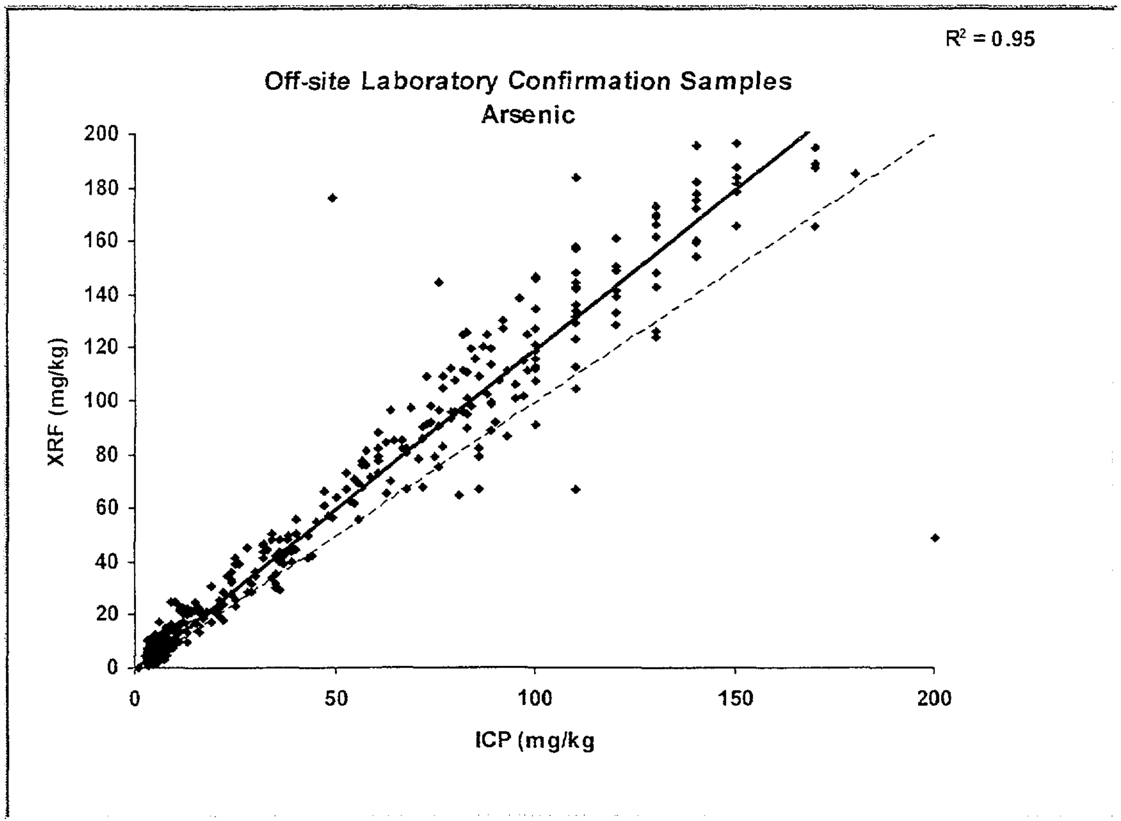
Figure 20

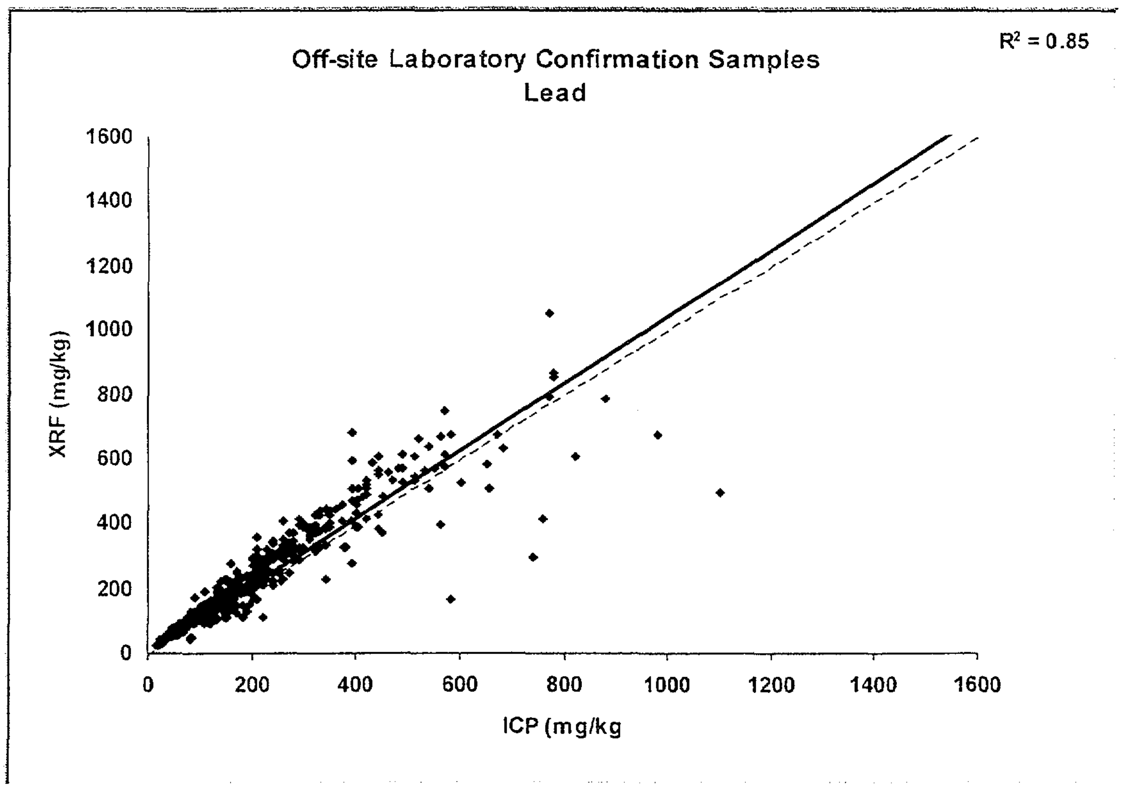




2/2/01 06:52 AM

Figure 21





2/7/01 11:11 AM

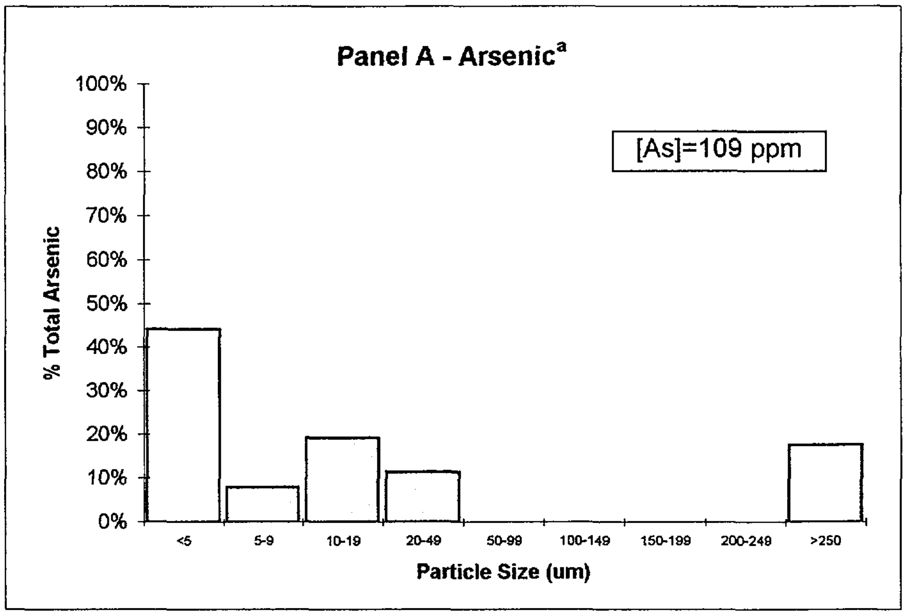
APPENDIX B

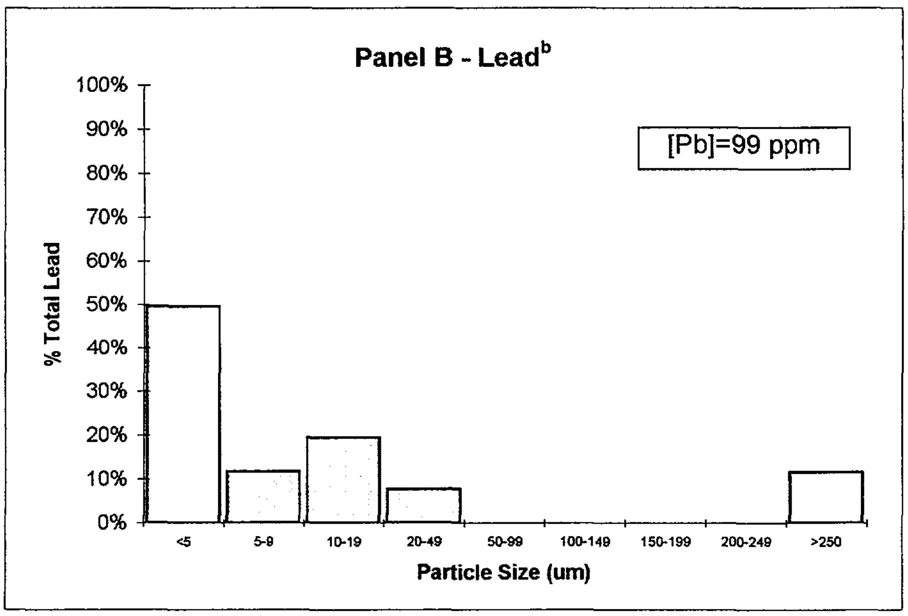
Physico-Chemical Characterization Data

APPENDIX B1

Distribution of Arsenic and Lead Mass by Particle Size

DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-100)

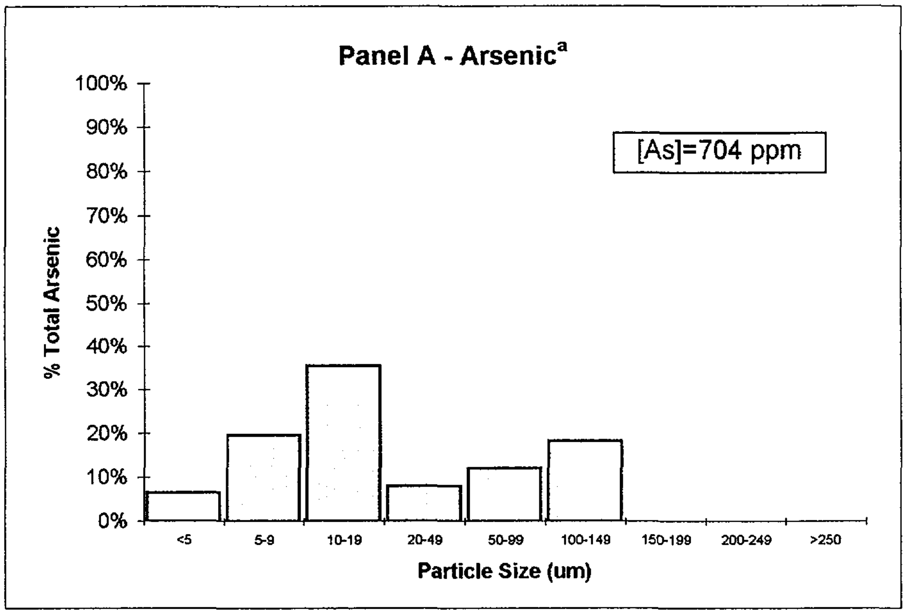


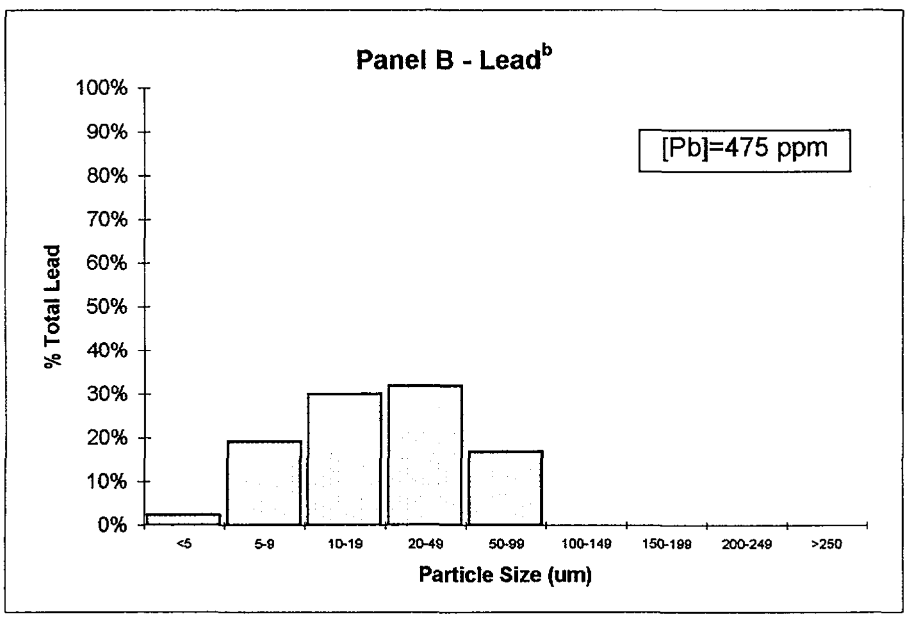


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS BY PARTICLE SIZE (ND-98-102)

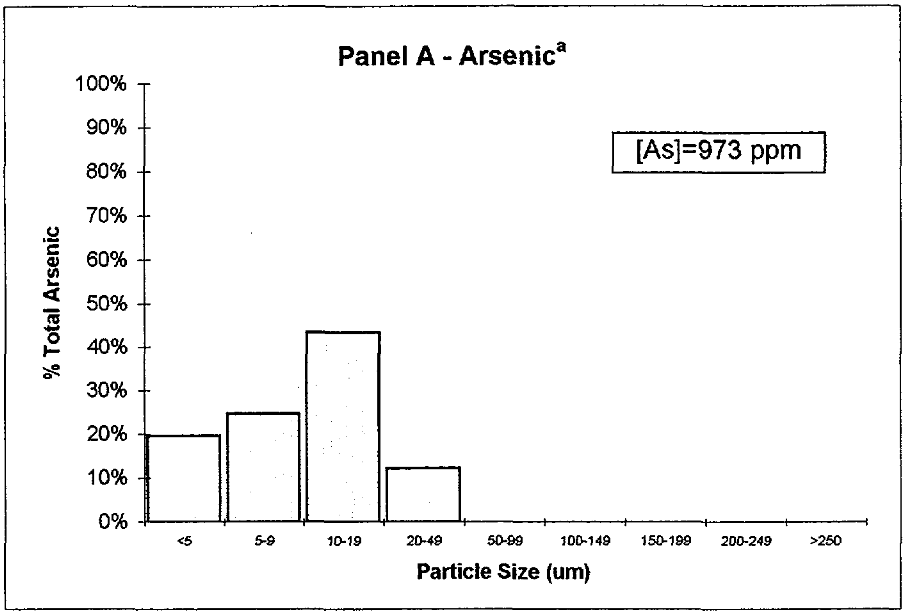


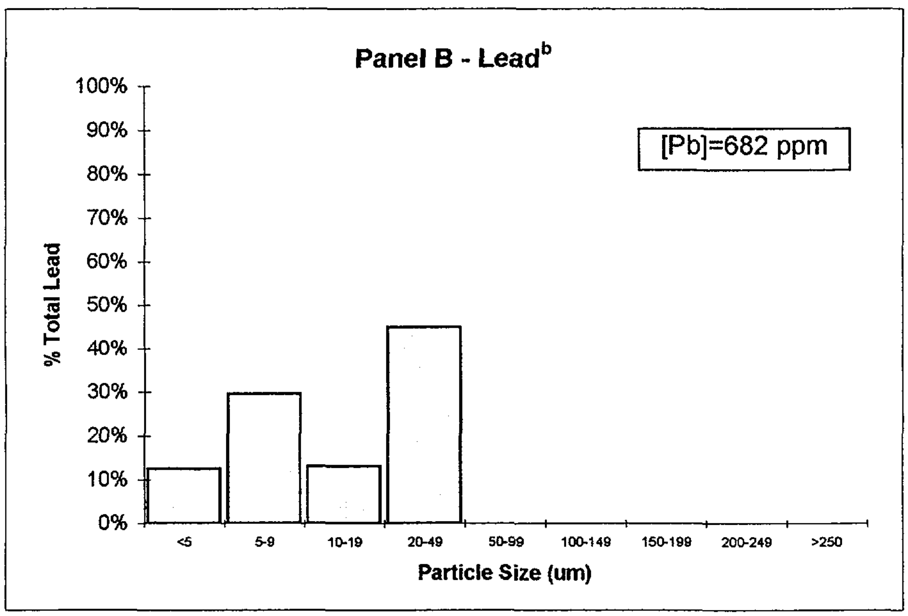


a - Particle size of the Arsenic-bearing phase of the test sample.

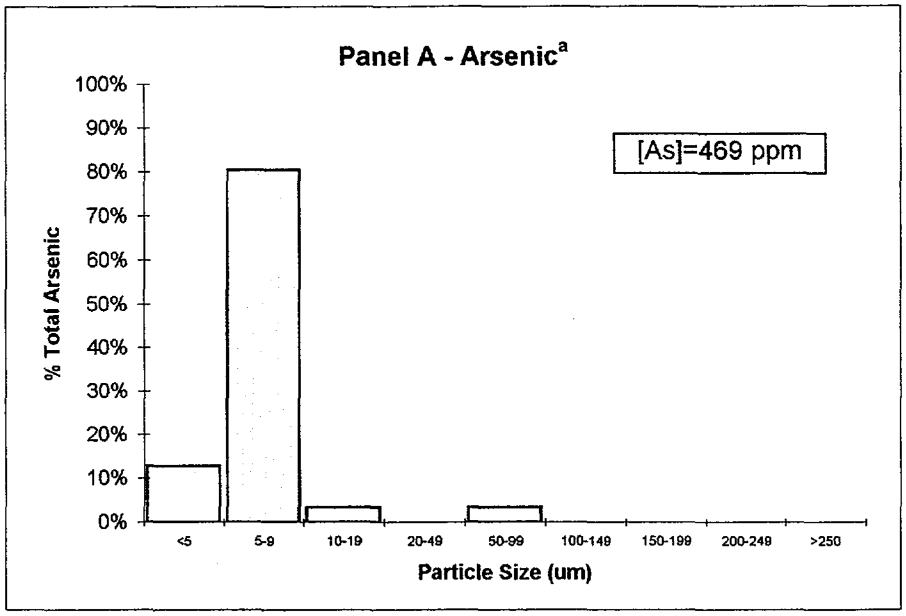
b - Particle size of the Lead-bearing phase of the test sample.

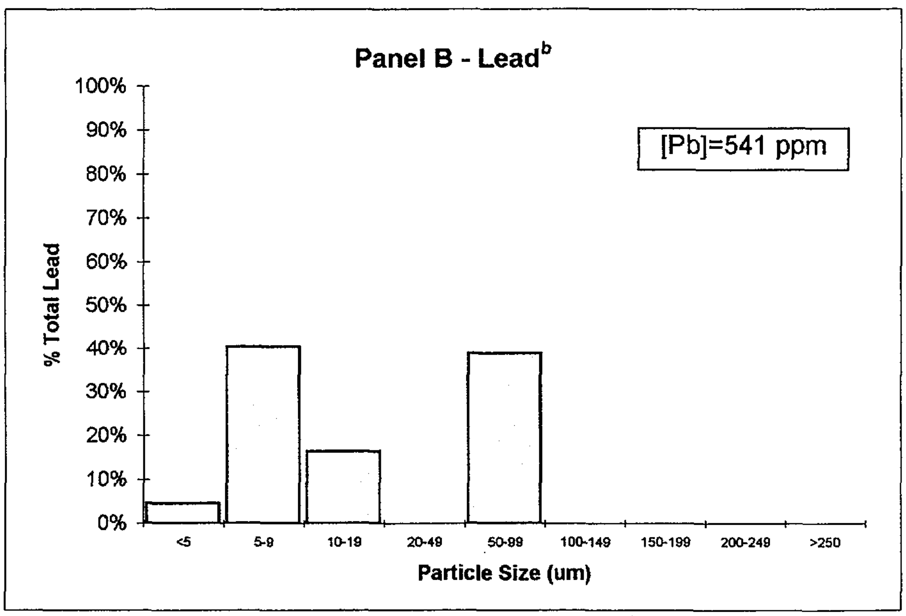
DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-106)





DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-110)

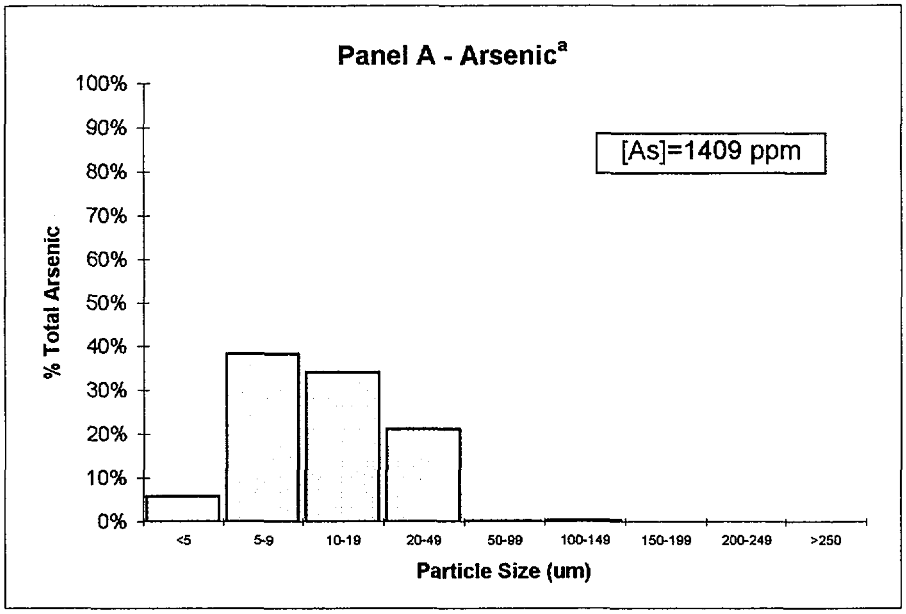


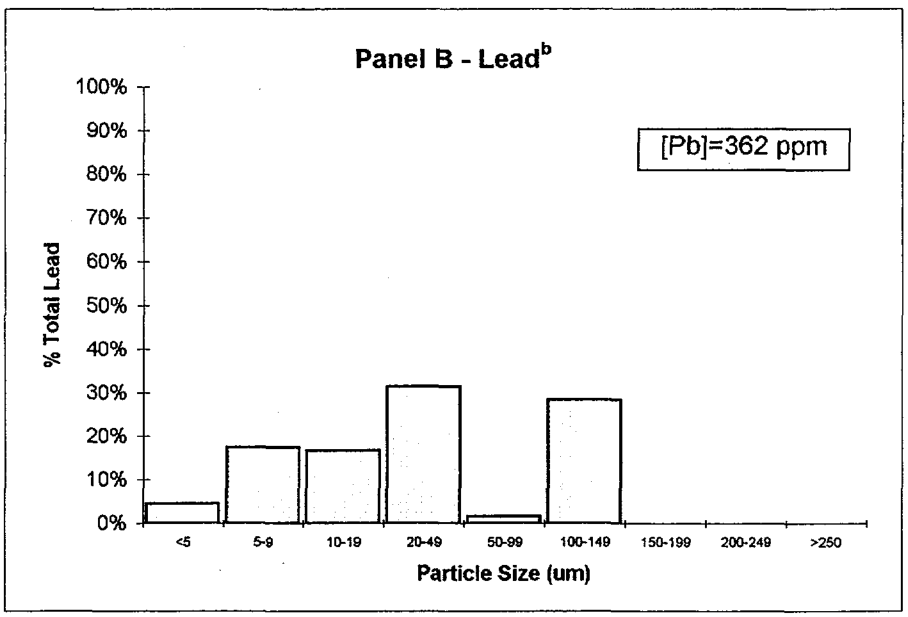


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-113)

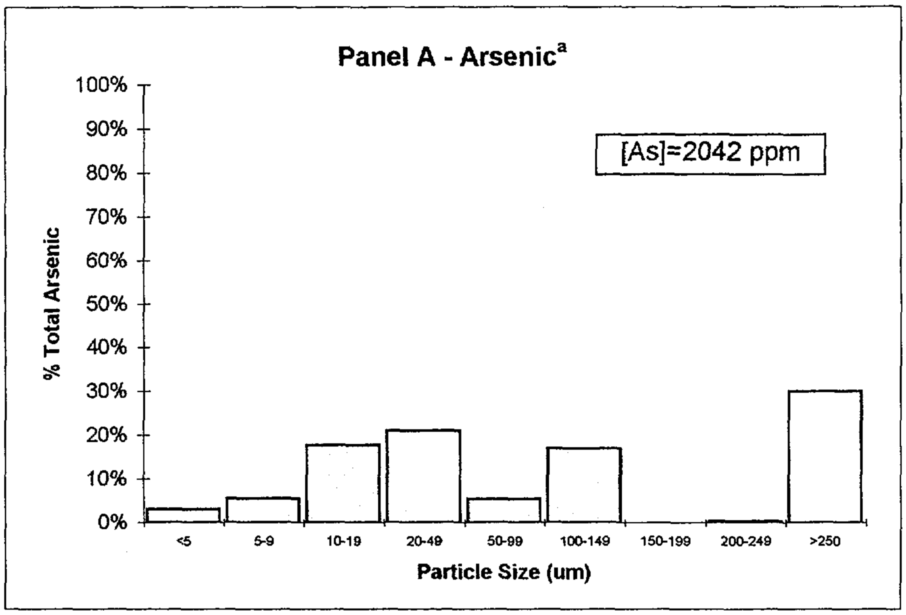


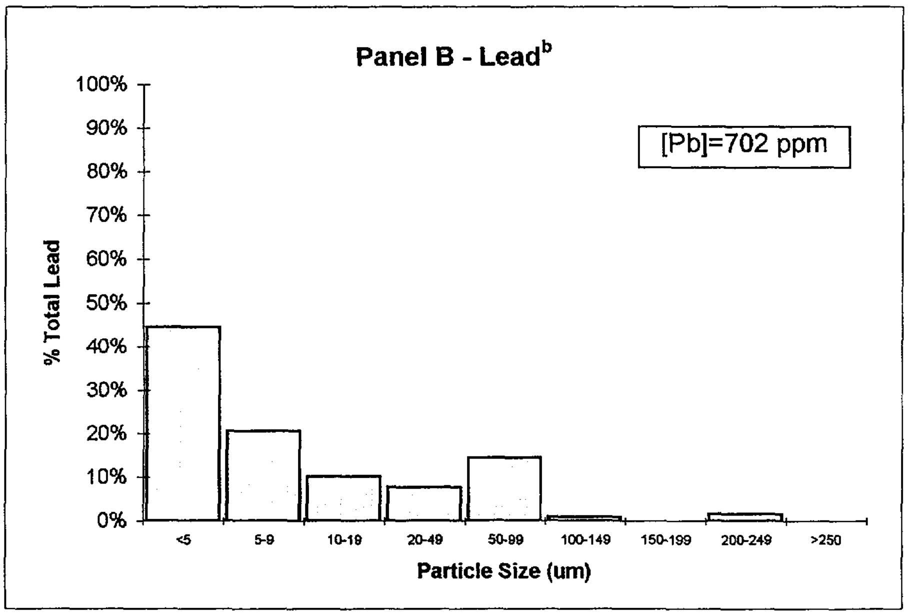


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS BY PARTICLE SIZE (ND-98-114)

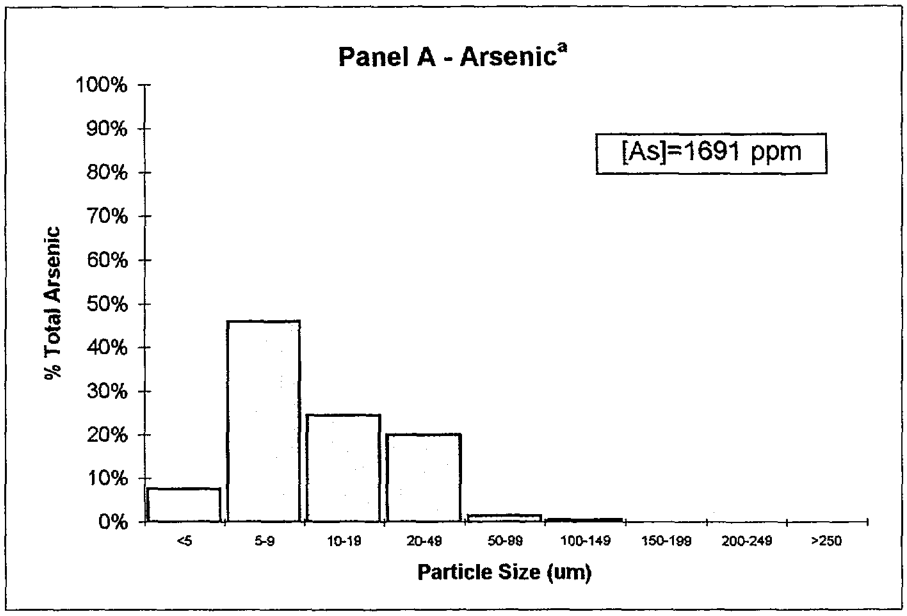


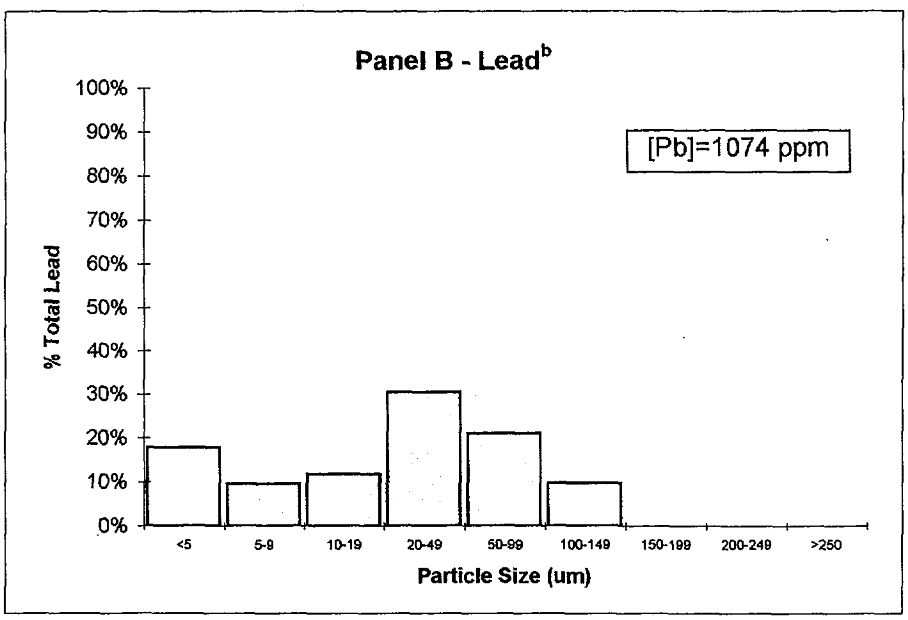


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS BY PARTICLE SIZE (ND-98-115)

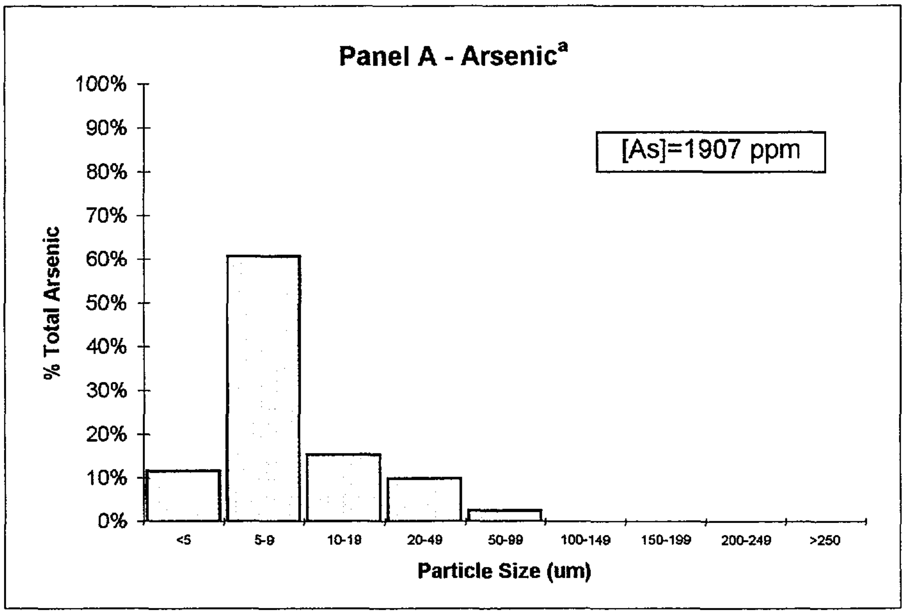


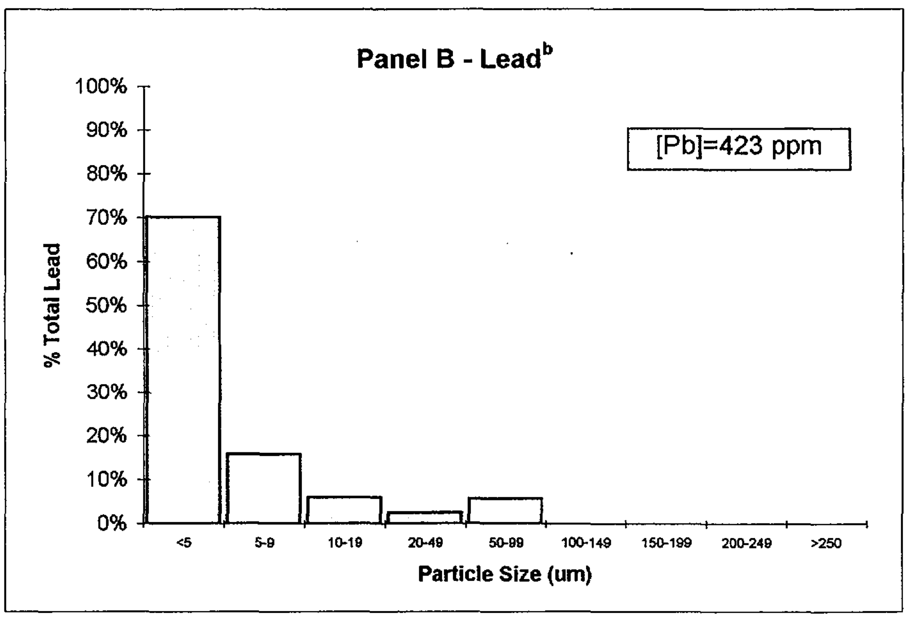


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-117)

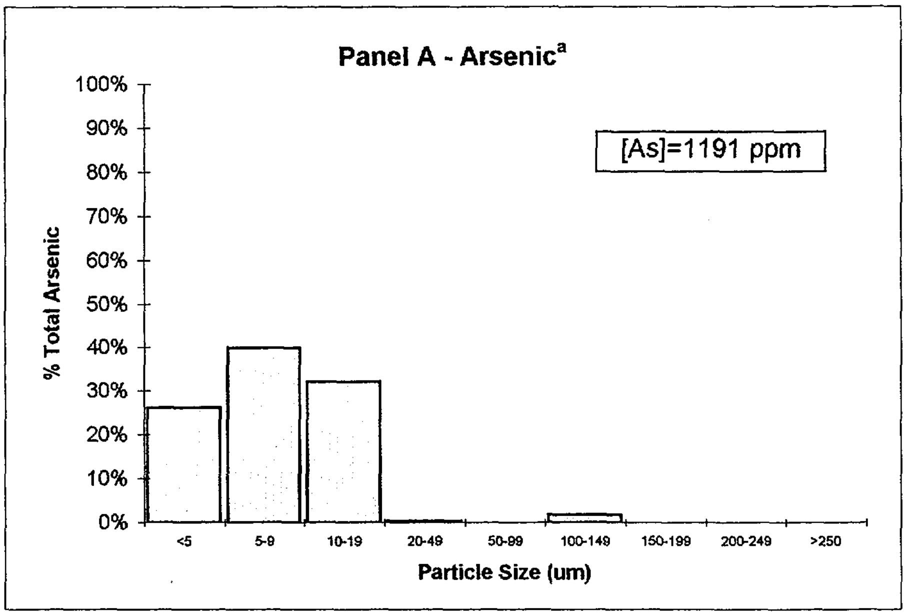


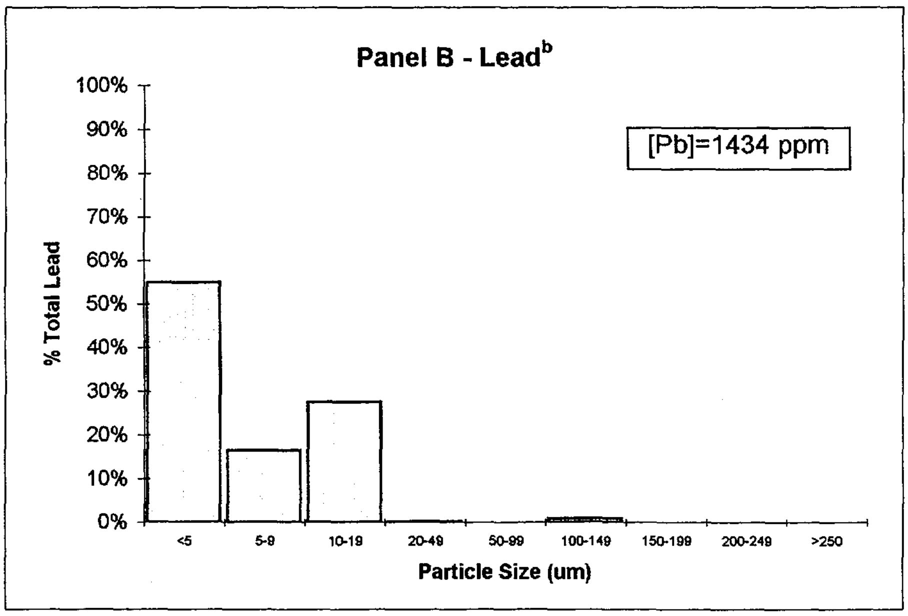


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS BY PARTICLE SIZE (ND-98-118)

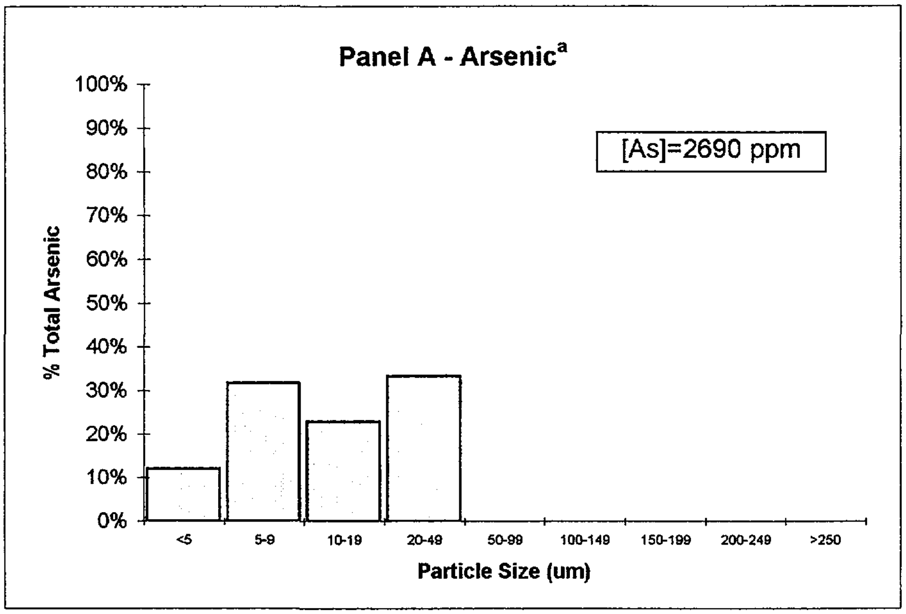


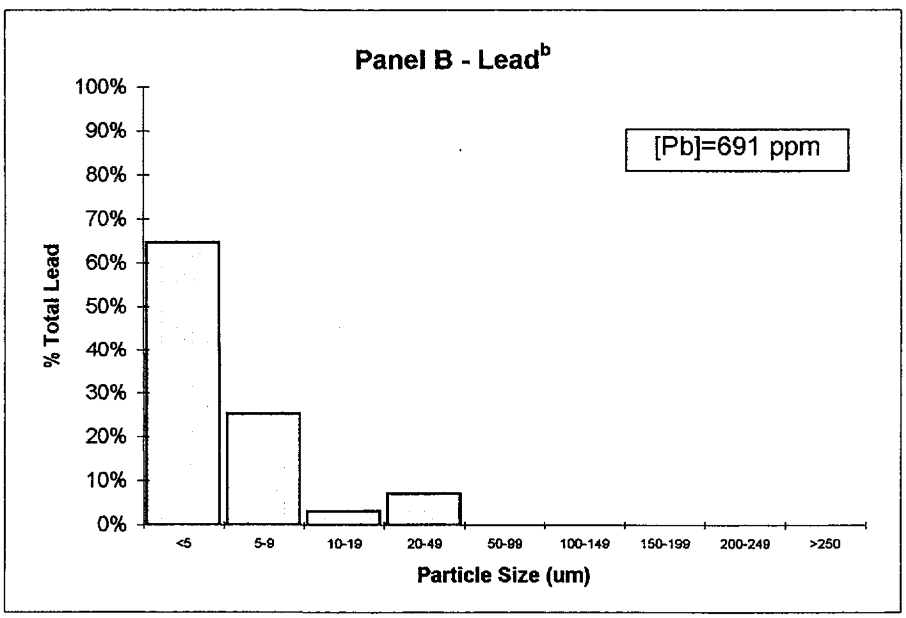


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-119)

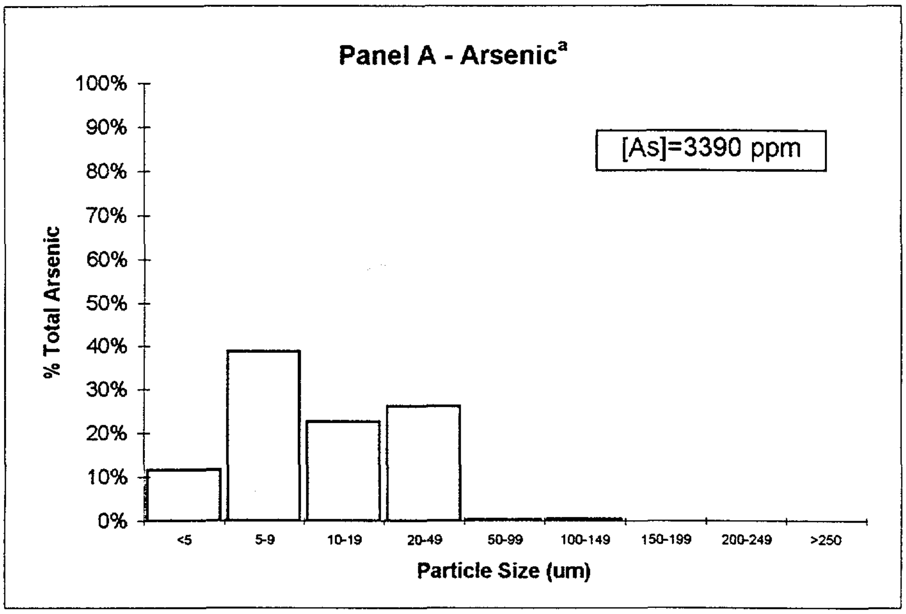


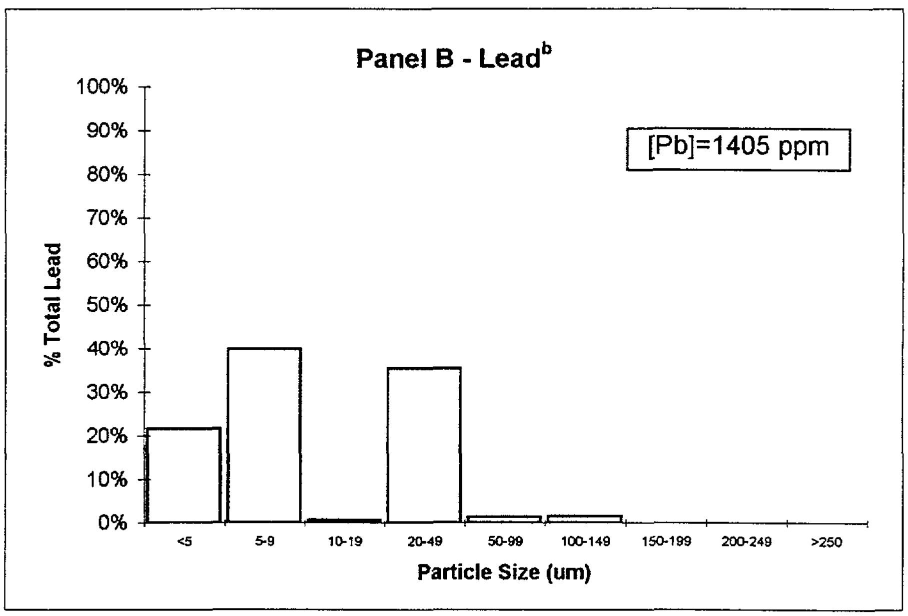


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-120)

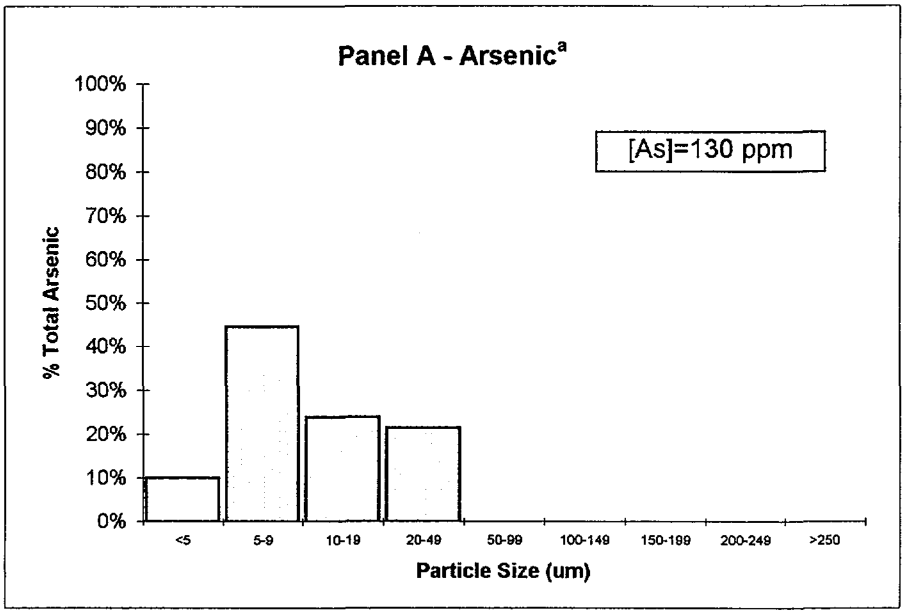


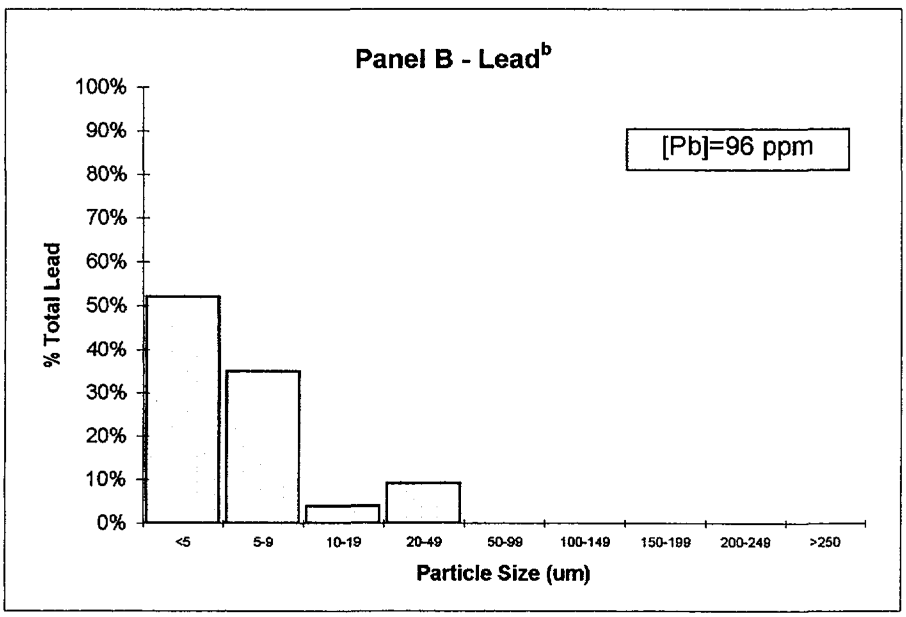


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS BY PARTICLE SIZE (ND-98-22)

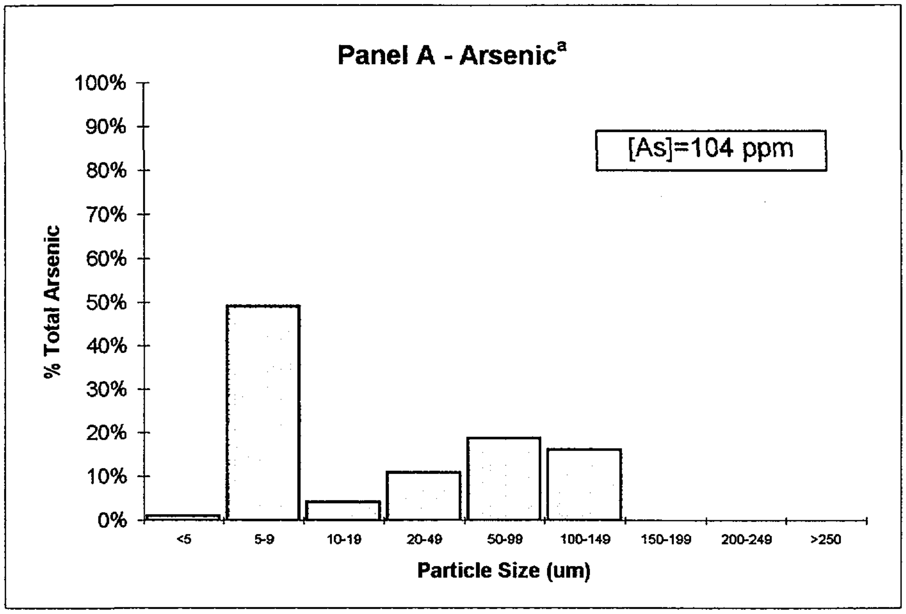


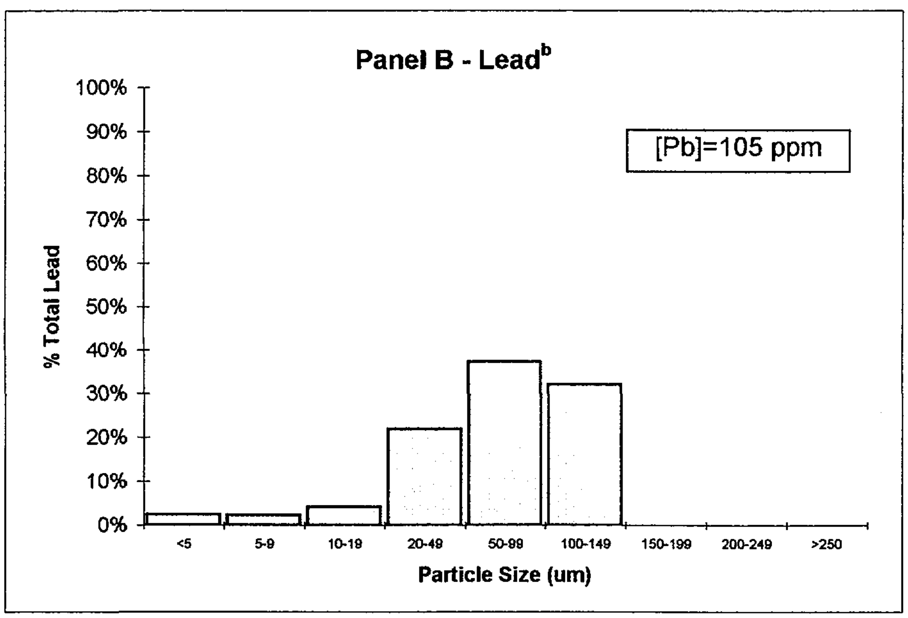


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS BY PARTICLE SIZE (ND-98-26)

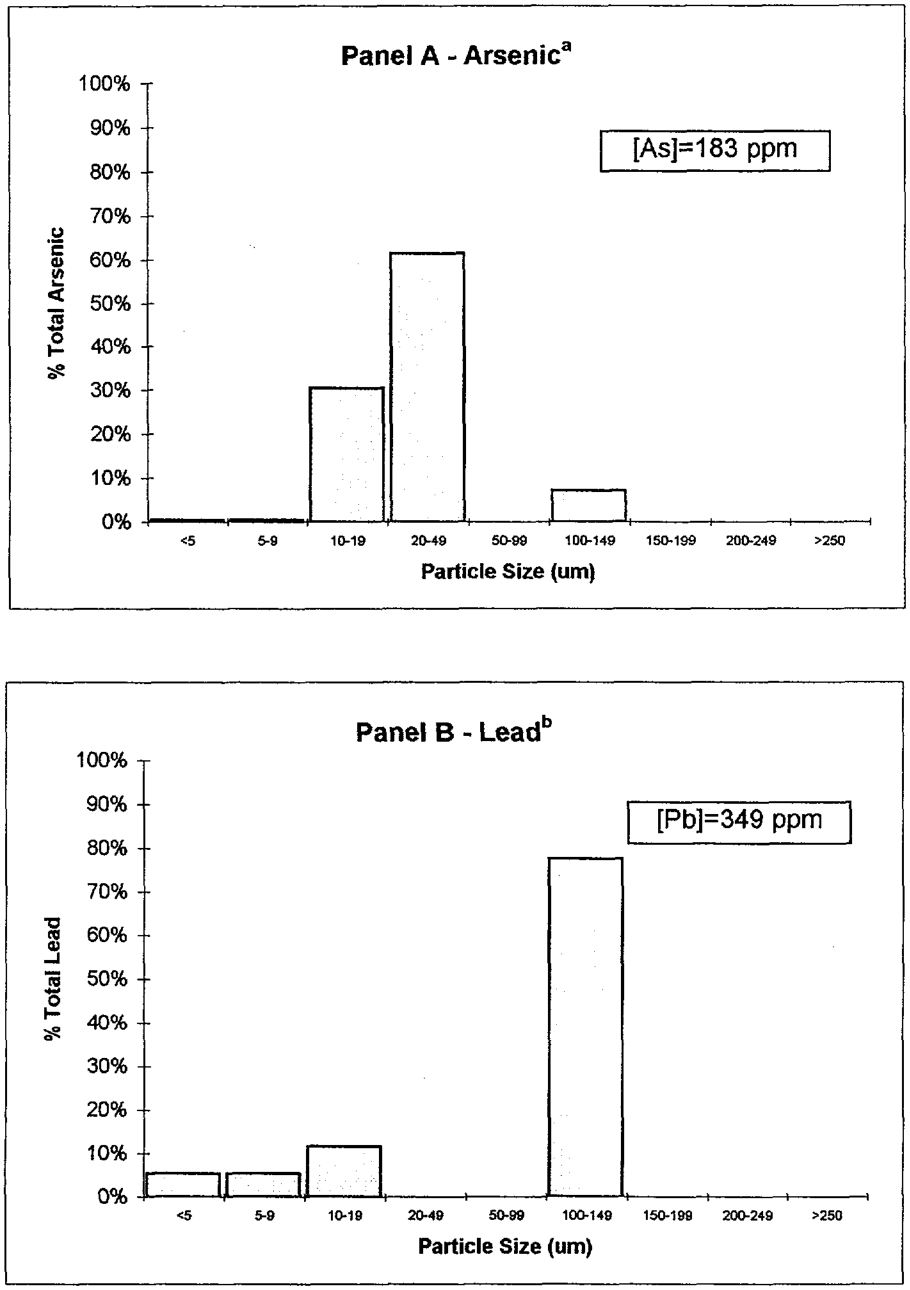




a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

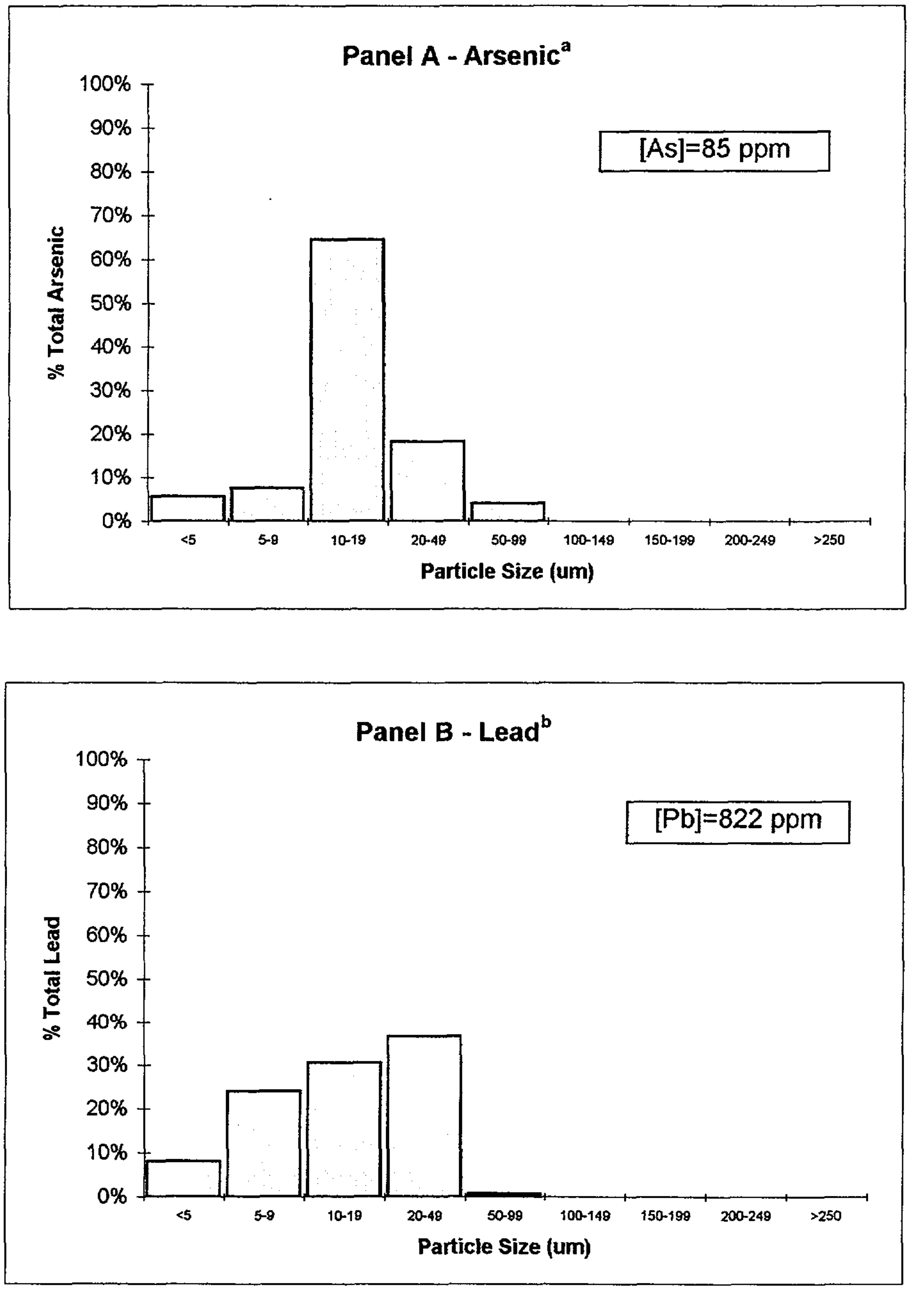
DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-27)



a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

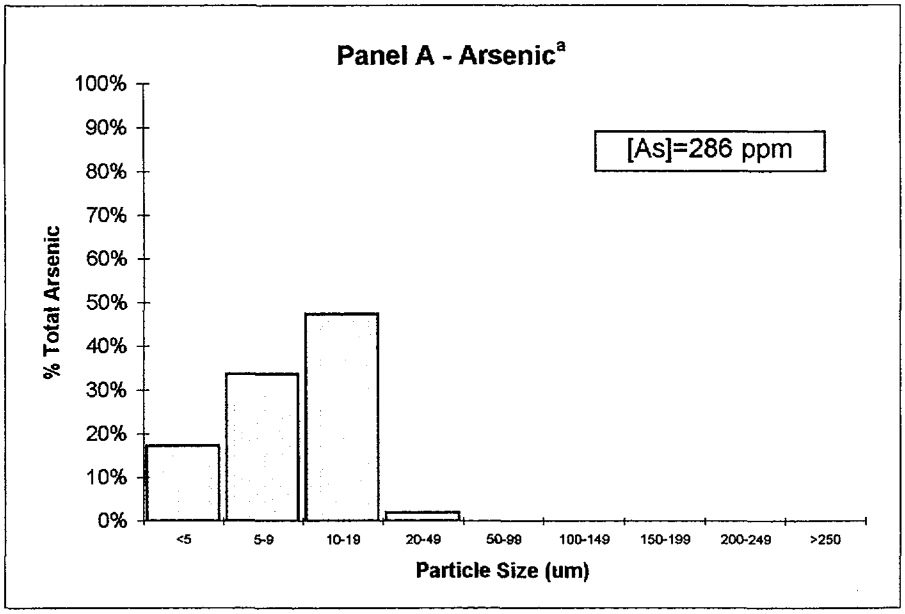
DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-31)

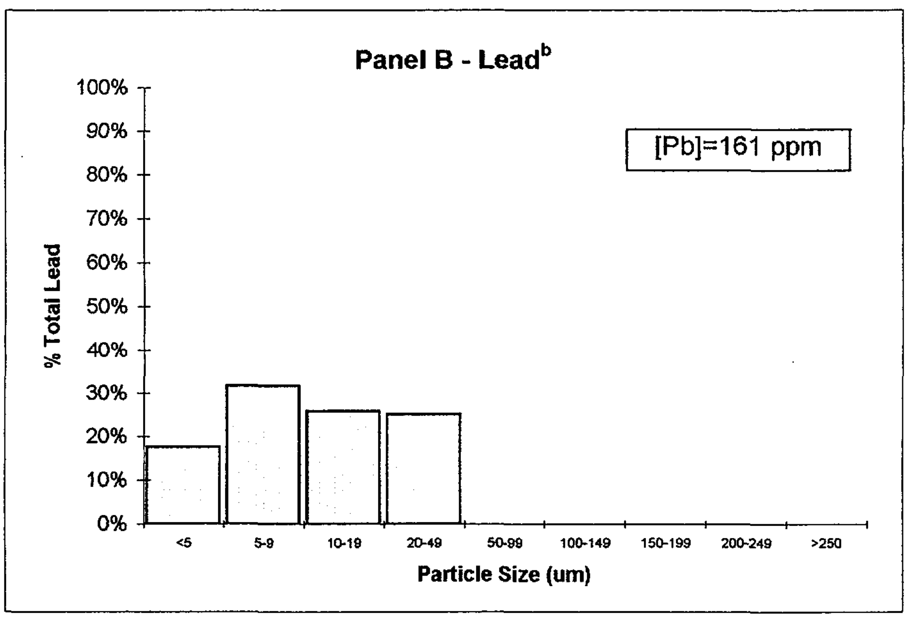


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-44)

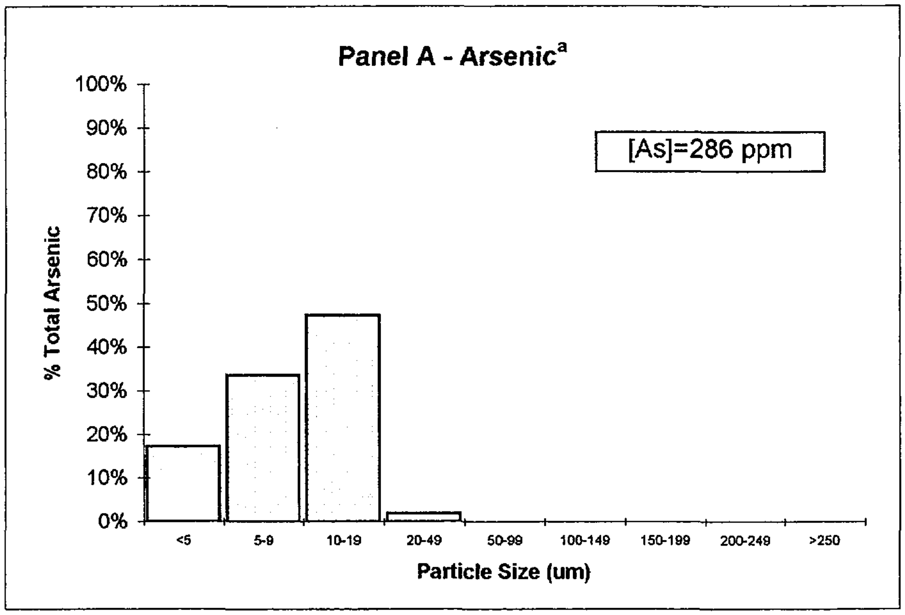


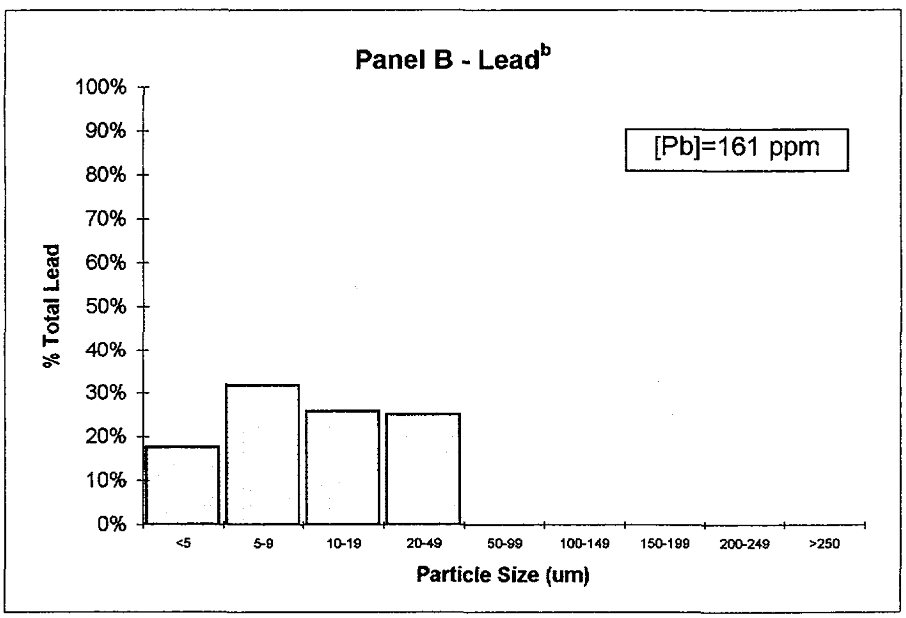


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-44)

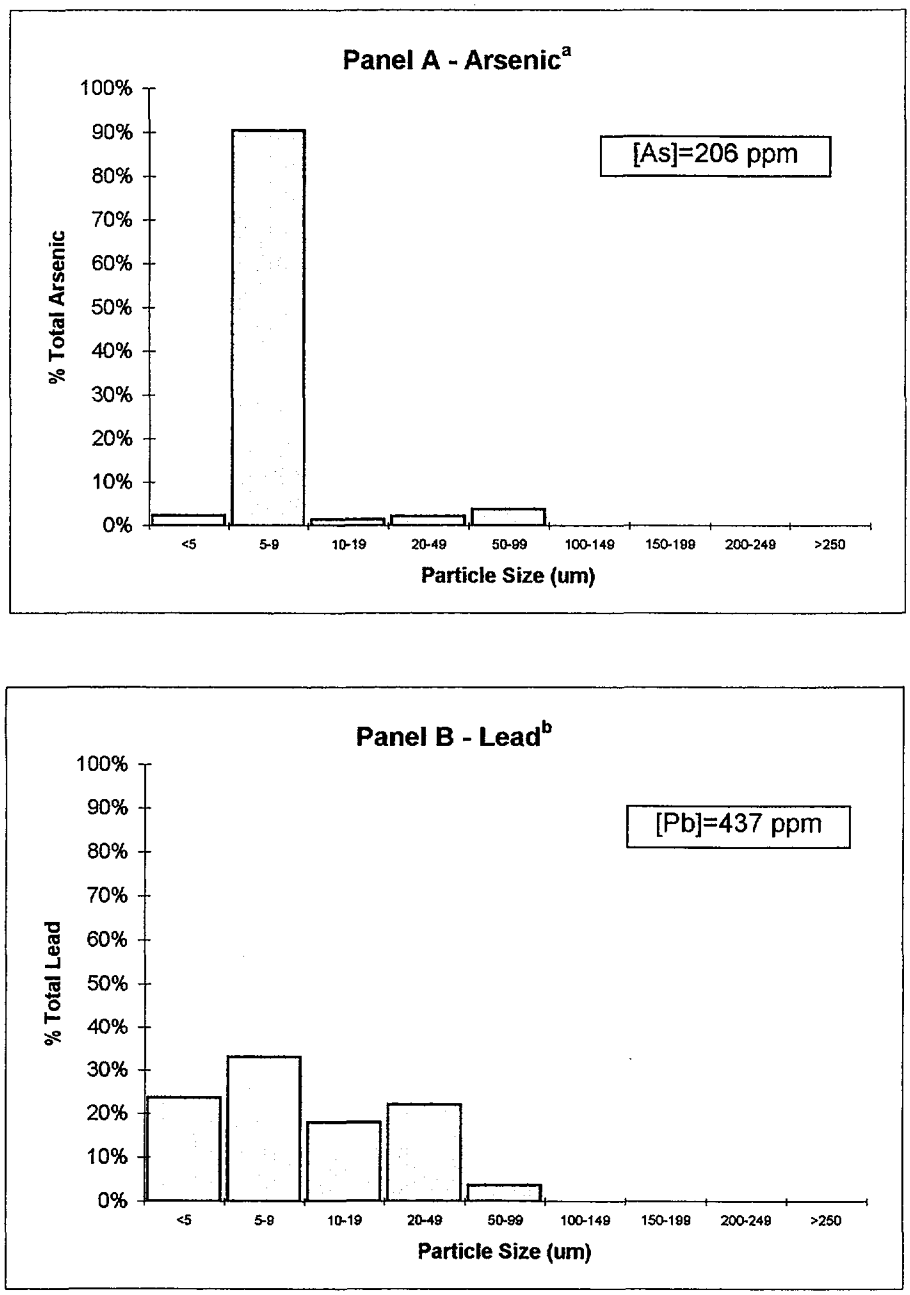




a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

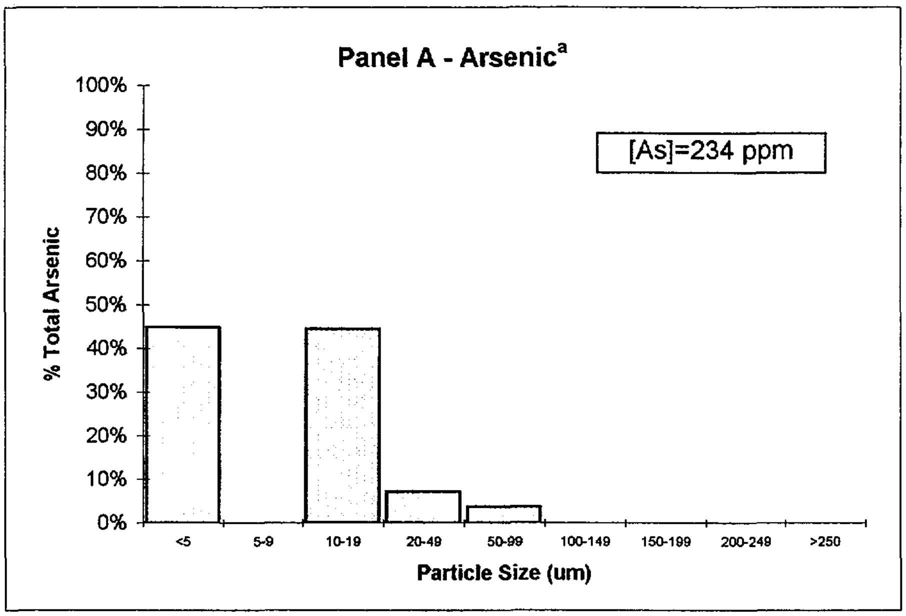
DISTRIBUTION OF ARSENIC & LEAD MASS BY PARTICLE SIZE (ND-98-47)

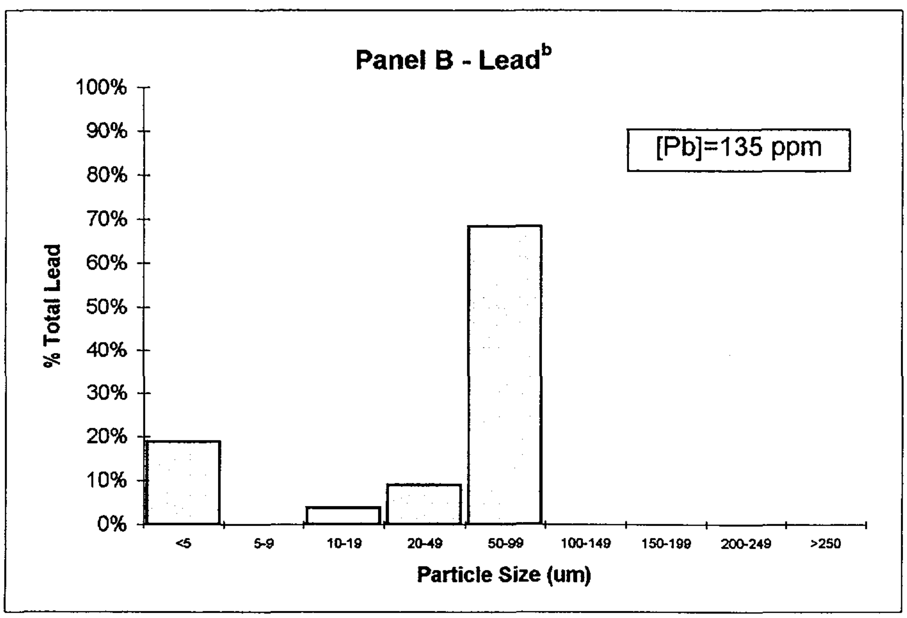


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS BY PARTICLE SIZE (ND-98-56)

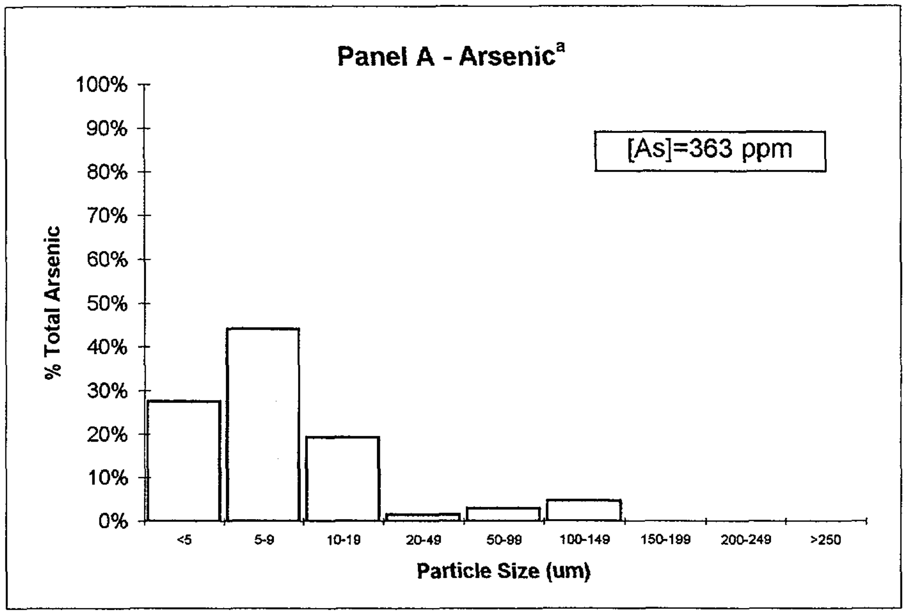


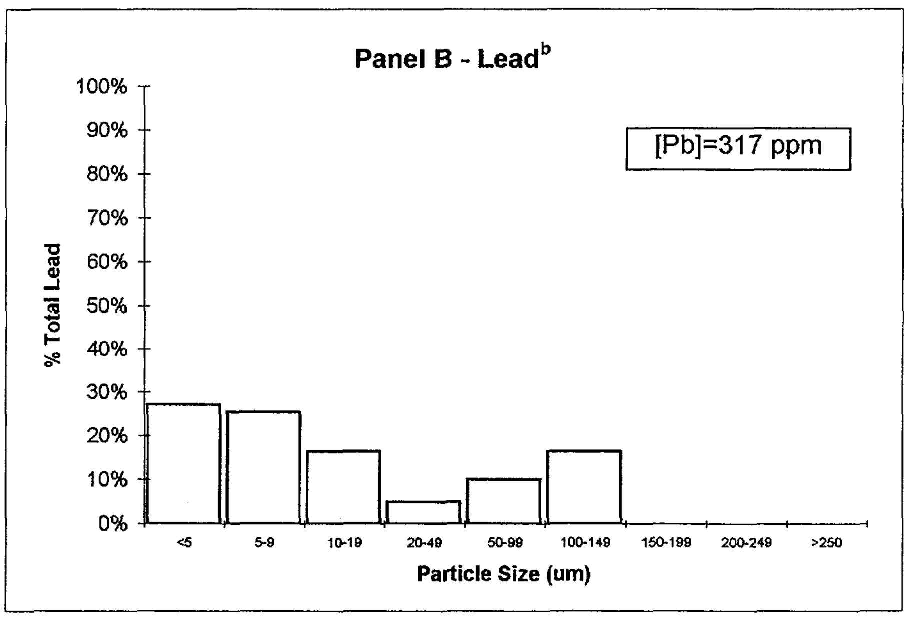


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-66)

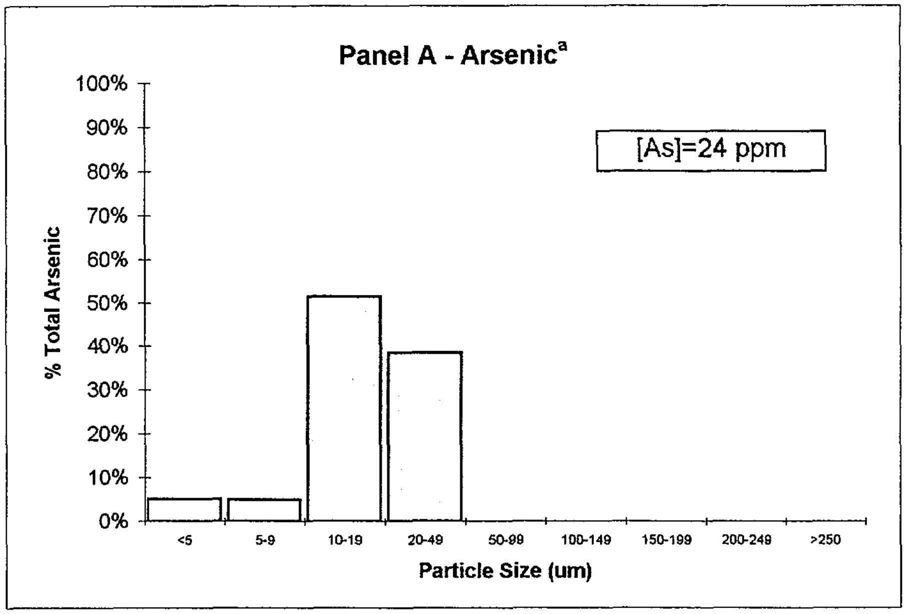


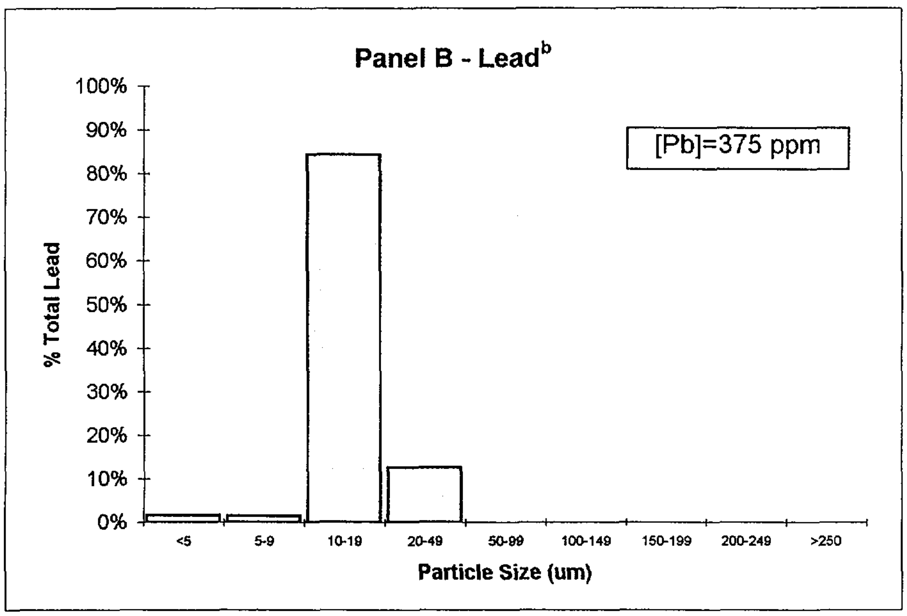


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS
BY PARTICLE SIZE (ND-98-72)

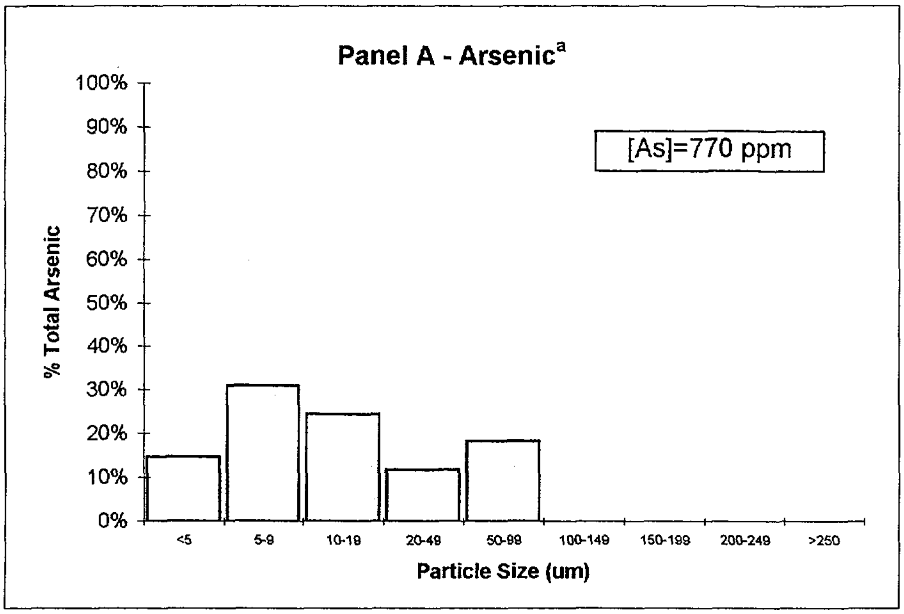


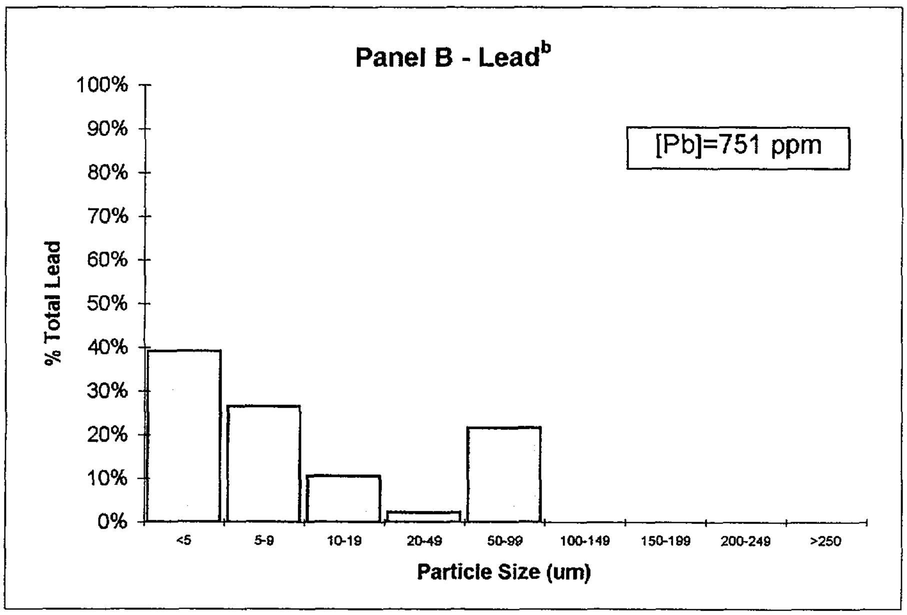


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS BY PARTICLE SIZE (ND-98-81)

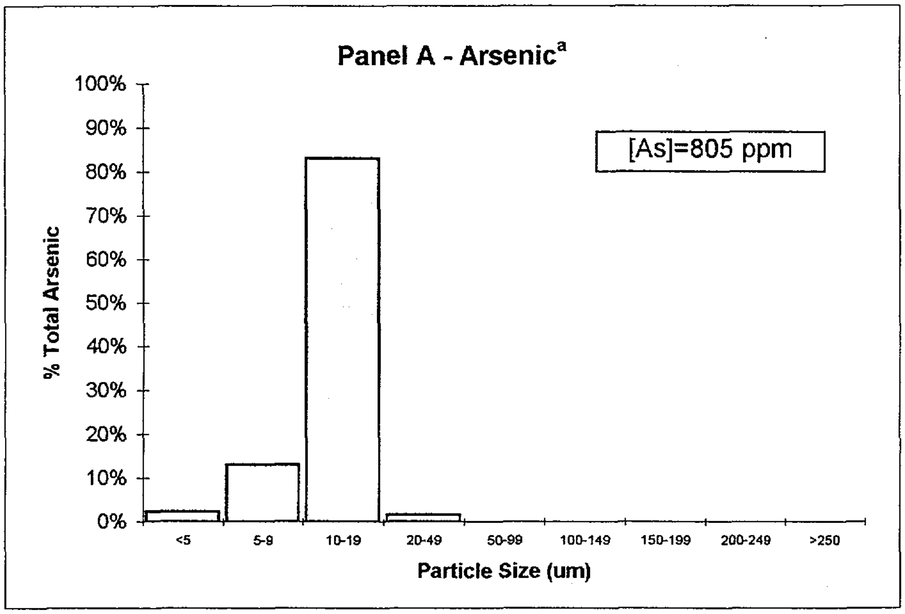


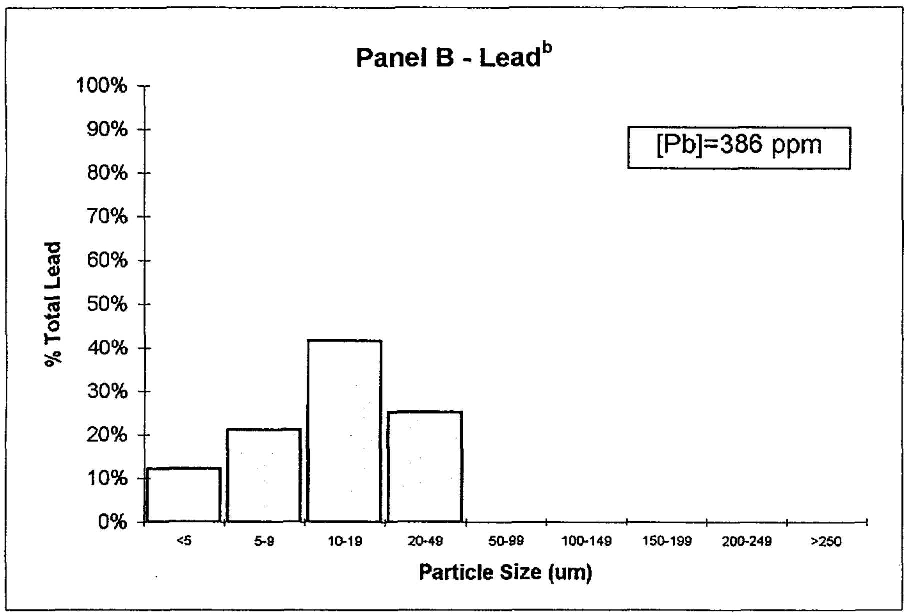


a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

DISTRIBUTION OF ARSENIC & LEAD MASS BY PARTICLE SIZE (ND-98-98)





a - Particle size of the Arsenic-bearing phase of the test sample.

b - Particle size of the Lead-bearing phase of the test sample.

APPENDIX B2

Arsenic, Cadmium, Lead and Zinc in 1998 Bulk Samples and Fines

Arsenic, Cadmium, Lead and Zinc in 1998 Bulk Samples and Fines
(mg/Kg)

Sample ID	As		Cd		Pb		Zn	
	Bulk	Fine	Bulk	Fine	Bulk	Fine	Bulk	Fine
ND-98-001	104	108	8	5	192	172	132	155
ND-98-002	52	86	6	6	113	124	188	216
ND-98-003	107	85	6	6	193	228	225	261
ND-98-004	13	27	4	4	84	100	129	146
ND-98-005	147	194	5	5	92	97	115	142
ND-98-006	26	73	2	3	79	93	209	230
ND-98-007	1	46	7	4	166	138	220	216
ND-98-007DUP	-5	NA	3	NA	182	NA	219	NA
ND-98-008	-6	11	5	5	115	150	241	354
ND-98-009	15	56	6	6	166	197	173	201
ND-98-010	26	-9	5	5	65	73	109	121
ND-98-011	27	55	3	4	52	74	94	112
ND-98-012	14	30	3	4	138	146	290	331
ND-98-013	82	74	3	4	102	127	119	134
ND-98-014	100	112	4	4	147	159	181	175
ND-98-015	12	32	4	5	85	107	133	130
ND-98-015DUP	52	NA	5	NA	71	NA	129	NA
ND-98-016	10	124	3	4	49	66	99	117
ND-98-017	22	-6	5	11	257	392	294	354
ND-98-017DUP	NA	42	NA	11	NA	383	NA	373
ND-98-018	17	78	5	5	75	74	90	109
ND-98-019	39	6	8	6	219	257	201	208
ND-98-020	17	1	4	6	131	232	228	333
ND-98-021	93	184	5	4	145	198	180	228
ND-98-022	95	130	3	3	110	96	135	136
ND-98-022DUP	NA	113	NA	4	NA	115	NA	154
ND-98-023	110	107	6	5	176	203	292	272
ND-98-024	11	76	8	10	303	399	486	509
ND-98-025	91	95	6	3	141	146	152	128
ND-98-026	44	104	4	3	105	105	100	91
ND-98-027	61	183	10	10	353	349	641	625
ND-98-028	53	14	4	4	131	167	195	249
ND-98-029	93	138	6	5	139	163	72	93
ND-98-030	42	154	4	2	410	537	109	114
ND-98-030DUP	81	NA	2	NA	466	NA	114	NA
ND-98-031	65	85	6	8	798	822	555	610
ND-98-032	152	147	5	4	143	136	193	118
ND-98-033	943	218	8	9	304	190	346	229
ND-98-033DUP	NA	205	NA	8	NA	189	NA	222
ND-98-034	96	152	4	6	366	476	299	335
ND-98-035	163	198	8	9	474	582	178	213
ND-98-036	209	184	4	6	213	195	242	263
ND-98-037	176	224	3	4	91	82	345	287
ND-98-038	169	220	5	9	138	154	201	220
ND-98-039	62	149	7	9	384	456	416	416

NA: Not analyzed

Arsenic, Cadmium, Lead and Zinc in 1998 Bulk Samples and Fines
(mg/Kg)

Sample ID	As		Cd		Pb		Zn	
	Bulk	Fine	Bulk	Fine	Bulk	Fine	Bulk	Fine
ND-98-040	115	181	4	5	147	171	178	200
ND-98-041	114	153	5	7	405	498	184	186
ND-98-042	95	94	4	6	219	239	238	287
ND-98-043	195	223	6	9	174	223	159	213
ND-98-044	260	286	5	6	157	161	199	133
ND-98-045	561	622	22	18	668	620	1230	1083
ND-98-046	218	319	6	8	432	481	333	327
ND-98-047	180	206	6	5	400	437	358	369
ND-98-048	277	353	7	4	145	178	121	100
ND-98-048DUP	310	NA	6	NA	149	NA	109	NA
ND-98-049	249	386	8	7	541	583	423	505
ND-98-050	504	637	6	7	435	481	239	232
ND-98-051	213	327	5	9	235	285	245	251
ND-98-052	204	287	8	9	254	323	160	182
ND-98-053	335	453	9	10	432	418	339	291
ND-98-054	218	333	5	8	80	118	144	183
ND-98-055	300	231	20	24	461	371	286	261
ND-98-055DUP	NA	226	NA	24	NA	393	NA	258
ND-98-056	204	234	5	5	137	125	150	148
ND-98-057	164	265	10	14	349	410	423	466
ND-98-058	142	187	3	3	207	217	130	139
ND-98-059	216	215	4	5	319	303	250	256
ND-98-060	161	300	5	6	462	546	111	128
ND-98-060DUP	240	NA	6	NA	502	NA	126	NA
ND-98-061	261	443	10	11	173	241	127	156
ND-98-062	258	300	7	8	207	204	120	141
ND-98-063	445	556	7	9	298	350	178	229
ND-98-064	248	297	9	11	453	669	412	501
ND-98-065	642	709	11	10	359	434	275	306
ND-98-066	211	363	6	8	304	317	216	213
ND-98-067	385	591	8	14	744	974	227	217
ND-98-067DUP	499	NA	11	NA	748	NA	231	NA
ND-98-068	637	928	9	9	4158	3507	1354	1436
ND-98-069	85	86	12	13	484	505	796	668
ND-98-070	349	435	10	7	584	666	435	501
ND-98-071	181	335	8	13	568	632	679	889
ND-98-072	1	24	8	8	352	375	382	396
ND-98-073	472	445	8	9	253	261	138	154
ND-98-074	397	279	20	19	641	494	493	660
ND-98-074DUP	NA	315	NA	17	NA	583	NA	528
ND-98-075	208	323	10	9	480	572	204	303
ND-98-076	210	404	8	7	193	259	131	196
ND-98-077	244	208	8	9	401	421	337	304
ND-98-078	336	491	10	10	411	391	474	408
ND-98-079	144	258	4	5	308	335	318	252

NA: Not analyzed

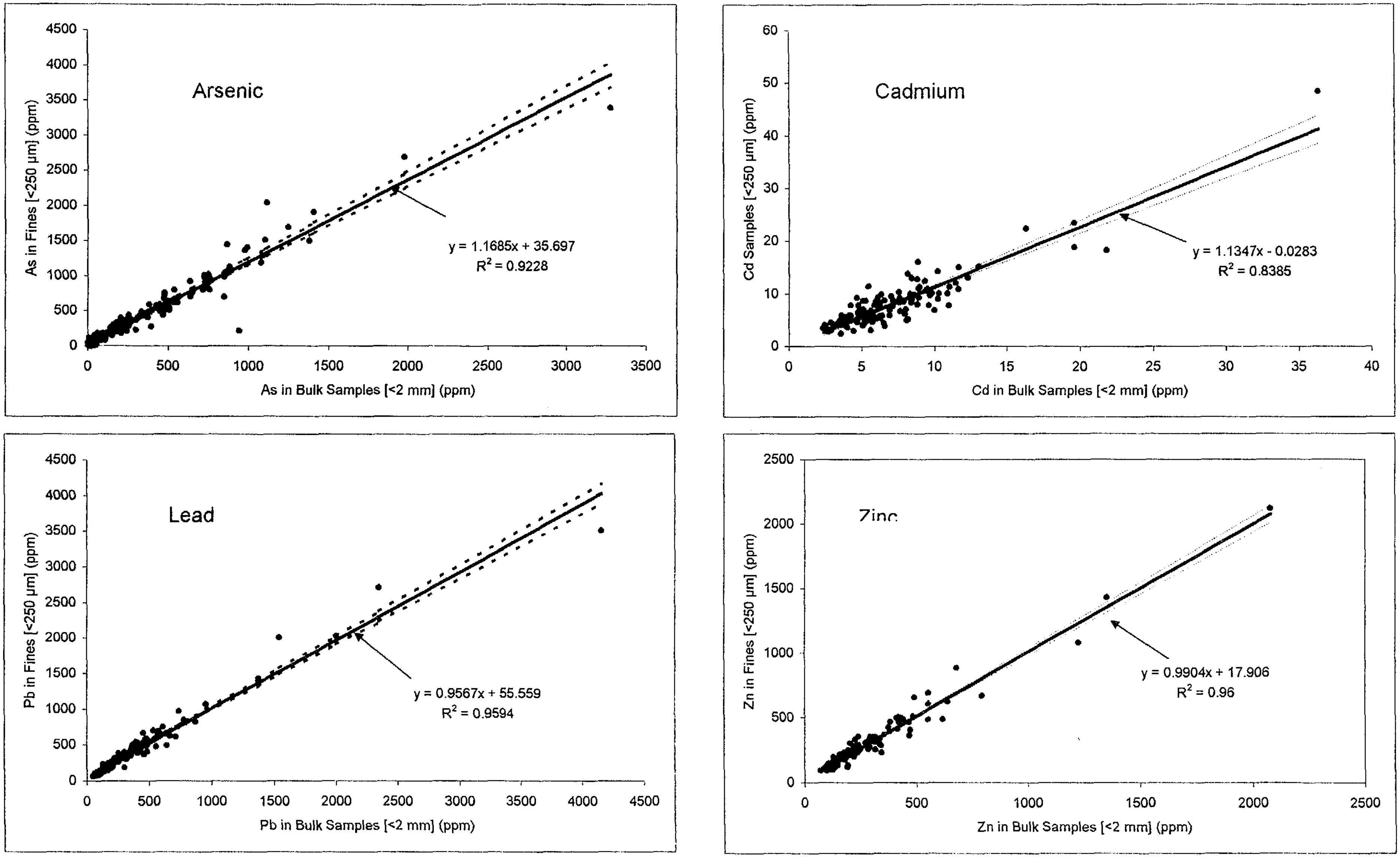
Arsenic, Cadmium, Lead and Zinc in 1998 Bulk Samples and Fines

(mg/Kg)

Sample ID	As		Cd		Pb		Zn	
	Bulk	Fine	Bulk	Fine	Bulk	Fine	Bulk	Fine
ND-98-080	478	504	11	11	483	586	175	195
ND-98-080DUP	NA	535	NA	13	NA	580	NA	218
ND-98-081	653	770	12	11	611	751	321	336
ND-98-082	346	464	4	8	284	345	106	142
ND-98-083	479	765	5	7	369	505	443	489
ND-98-084	275	371	4	5	163	225	141	118
ND-98-085	304	372	36	48	781	847	2079	2122
ND-98-086	512	545	9	12	637	654	283	287
ND-98-087	430	576	5	6	237	288	109	147
ND-98-088	454	499	6	5	414	464	191	211
ND-98-089	379	485	5	6	503	541	316	311
ND-98-090	449	591	7	6	373	445	222	199
ND-98-091	478	678	6	8	281	333	165	206
ND-98-092	1105	1510	10	10	2003	2031	221	277
ND-98-093	887	1125	9	10	350	410	306	350
ND-98-094	318	413	9	8	489	410	377	423
ND-98-095	510	510	11	8	717	619	551	489
ND-98-096	719	805	6	10	340	341	139	137
ND-98-097	729	1009	5	9	1542	2012	385	470
ND-98-098	540	805	7	7	337	386	228	233
ND-98-099	540	622	6	8	394	464	247	251
ND-98-100	109	109	5	5	103	99	127	100
ND-98-101	729	1014	5	5	872	827	199	217
ND-98-102	851	704	8	5	559	475	326	311
ND-98-103	734	877	10	8	324	383	215	230
ND-98-104	481	734	6	7	221	317	168	215
ND-98-105	851	983	9	13	484	539	137	181
ND-98-106	729	973	9	11	573	682	321	350
ND-98-107	978	1368	8	10	264	295	133	145
ND-98-108	376	409	5	6	188	215	114	140
ND-98-108DUP	335	NA	4	NA	242	NA	113	NA
ND-98-109	869	1449	16	22	2350	2713	468	466
ND-98-110	365	469	7	9	398	541	555	691
ND-98-111	760	800	6	6	318	306	141	150
ND-98-112	1378	1500	3	5	283	364	277	284
ND-98-113	994	1409	9	16	359	362	205	219
ND-98-114	1115	2042	4	5	534	702	172	183
ND-98-115	1247	1691	11	12	957	1074	183	195
ND-98-116	756	1019	5	5	328	341	338	340
ND-98-116DUP	NA	1161	NA	8	NA	371	NA	349
ND-98-117	1409	1907	8	8	363	423	232	271
ND-98-118	1080	1191	12	15	1375	1434	617	489
ND-98-119	1980	2690	8	10	572	691	245	289
ND-98-120	3282	3390	13	15	1375	1405	470	361

NA: Not analyzed

COMPARISON OF CONCENTRATIONS IN BULK AND FINE SOIL



appB2fig.xls

APPENDIX B3

Speciation

Arsenic Mass in Each Phase

Sample Number	ND-98-22	ND-98-26	ND-98-27	ND-98-31	ND-98-44	ND-98-47	ND-98-56	ND-98-66	ND-98-72	ND-98-81	ND-98-98
Total As (ppm)	130	104	183	85	286	206	234	363	24	770	805
PHASE											
Clays											
Anglesite											
As_2O_3	117.17	47.73	166.31	35.87	217.37	187.95	202.05	324.81		659.65	697.39
AsCaO					11.14						
AsSbO	5.53			1.29	47.70					62.33	
AsFeO											
Brass	0.04										
Galena											
Cerussite											
Fe Oxide	4.77	4.38		23.07	7.10	5.08	23.44	34.67	4.83	3.97	7.60
Mn Oxide	0.99	50.63		2.82	2.69	4.65	8.50	1.03	4.60	0.31	25.13
PbO											
Native Pb											
Organic						8.27					
PbAsO										37.58	51.13
$PbCrO_4$											
PbMO				4.98							23.75
Rutile		0.15									
$PbSiO_4$											
Solder						0.05		0.03			
Slag											
Phosphate	0.78	1.10	16.69	16.10				2.47	14.57	6.16	
Fe Sulfate	0.72			0.87							

Sample Number	ND-98-100	ND-98-102	ND-98-106	ND-98-110	ND-98-113	ND-98-114	ND-98-115	ND-98-117	ND-98-118	ND-98-119	ND-98-120
Total As (ppm)	109	704	973	469	1409	2042	1691	1907	1191	2690	3390
PHASE											
Clays		0.11					0.50				0.10
Anglesite											
As_2O_3	22.67	677.89	863.10	377.77	1257.68	1962.41	1425.10	1247.44	762.36	2106.50	3082.63
AsCaO											
AsSbO		14.97	27.22	4.94	133.49		148.50	575.15		541.34	151.08
AsFeO										18.56	
Brass		0.01									
Galena											
Cerussite											
Fe Oxide	5.48	3.26	41.20	13.70	6.00	11.48	27.69	79.00	25.69	6.56	68.27
Mn Oxide	22.11	1.86	26.37	0.99	11.83		28.83	5.42	0.73	0.26	0.63
PbO											
Native Pb											
Organic									362.34	1.07	
PbAsO		3.85		45.78		41.70	21.43			11.40	69.99
$PbCrO_4$											
PbMO	35.44					17.17	8.01		2.01	1.59	1.95
Rutile											
$PbSiO_4$											
Solder										0.01	
Slag	19.09								0.15		
Phosphate	1.47	2.02	15.12	25.82		8.88	30.15		37.73	2.72	15.35
Fe Sulfate	2.75	0.02				0.36	0.79				

Lead Mass in Each Phase

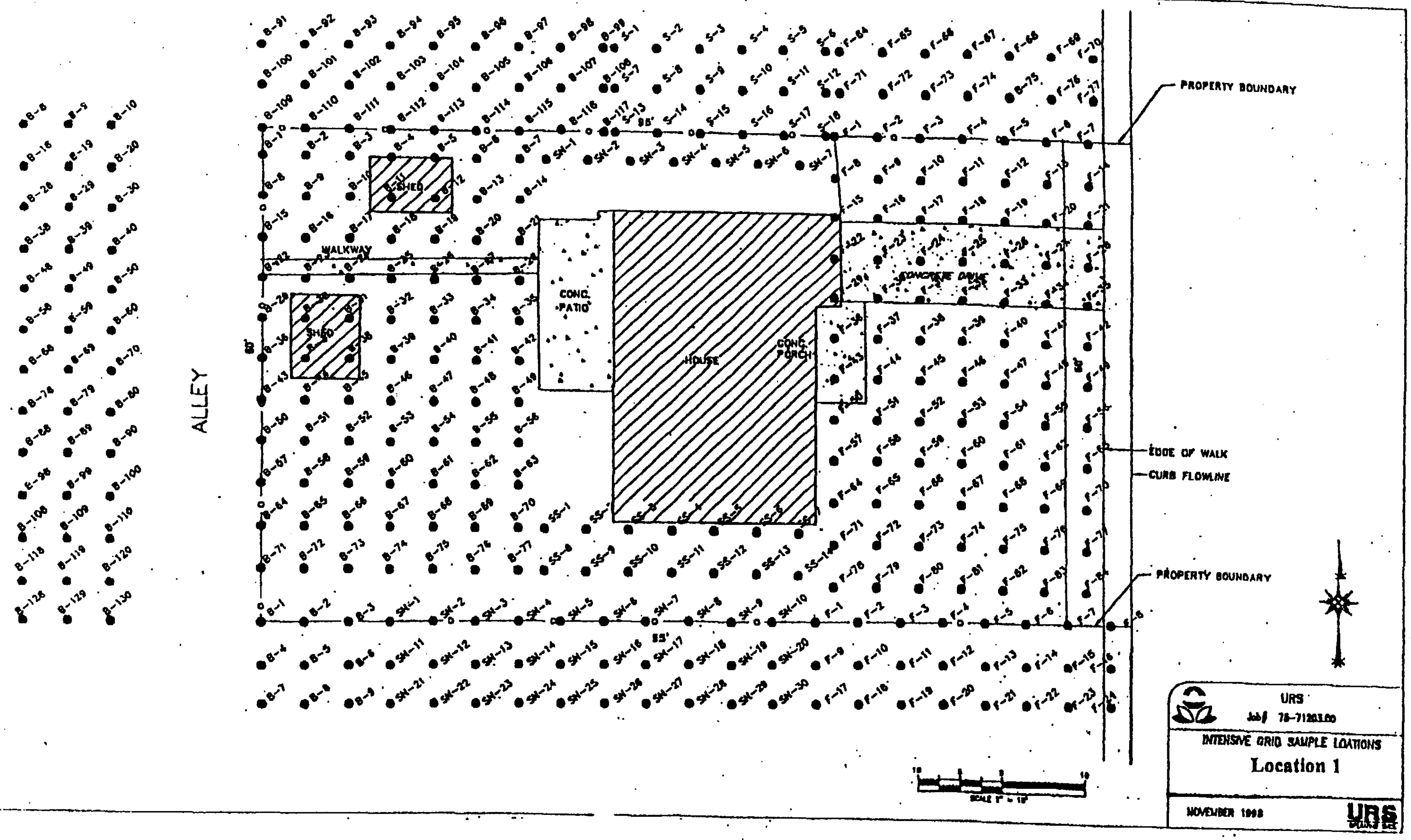
Sample Number	ND-98-22	ND-98-26	ND-98-27	ND-98-31	ND-98-44	ND-98-47	ND-98-56	ND-98-66	ND-98-72	ND-98-81	ND-98-98
Total Pb (ppm)	96	105	349	822	161	437	135	317	375	751	386
PHASE											
Clays											
Anglesite											
As2O3											
AsCaO					0.68						
AsSbO	0.01			0.02	0.13					0.15	
AsFeO											
Brass	0.1										
Galena											
Cerussite											
Fe Oxide	8.49	0.59		43.04	19.93	7.08	17.2	105.25	1.41	10.35	3.99
Mn Oxide	26.01	101.77		77.93	112.02	96.13	92.47	46.42	19.87	11.94	195.36
PbO							25.33				
Native Pb	35.33								278.82		
Organic						15.5					
PbAsO										438.4	120.17
PbCrO4				119.3							
PbMO				49.63							66.48
Rutile		0.01									
PbSiO4					28.25						
Solder						27.42		33.1			
Slag											
Phosphate	24.51	2.63	349	530.1		289.51		132.24	74.9	290.16	
Fe Sulfate	1.55			1.98		1.36					

Sample Number	ND-98-100	ND-98-102	ND-98-106	ND-98-110	ND-98-113	ND-98-114	ND-98-115	ND-98-117	ND-98-118	ND-98-119	ND-98-120
Total Pb (ppm)	99	475	682	541	362	702	1074	423	1434	691	1405
PHASE											
Clays		0.91					0.36				0.13
Anglesite				24.58							
As2O3											
AsCaO											
AsSbO		1.38	0.22	0.03	0.25		0.12	1.43		4.6	0.05
AsFeO										0.28	
Brass		0.22									
Galena	38.98										
Cerussite							41.06				
Fe Oxide	0.6	32.01	35.1	10.27	11.96	18.03	24.17	208.99	15.76	59.16	105.76
Mn Oxide	35.87	271.11	332.91	11.04	349.79		372.84	212.58	6.63	34.3	14.47
PbO											
Native Pb											
Organic										12.96	
PbAsO		169.35		153.72		293.38	83.79		996.08	46.06	485.69
PbCrO4							49.26				363.32
PbMO	20.71					143.9	37.33		6.57	76.46	16.12
Rutile											
PbSiO4			86.56								
Solder										24.46	
Slag									0.57		
Phosphate	2.84		227.21	341.37		246.01	464.23		408.39	432.73	419.46
Fe Sulfate						0.69	0.84				

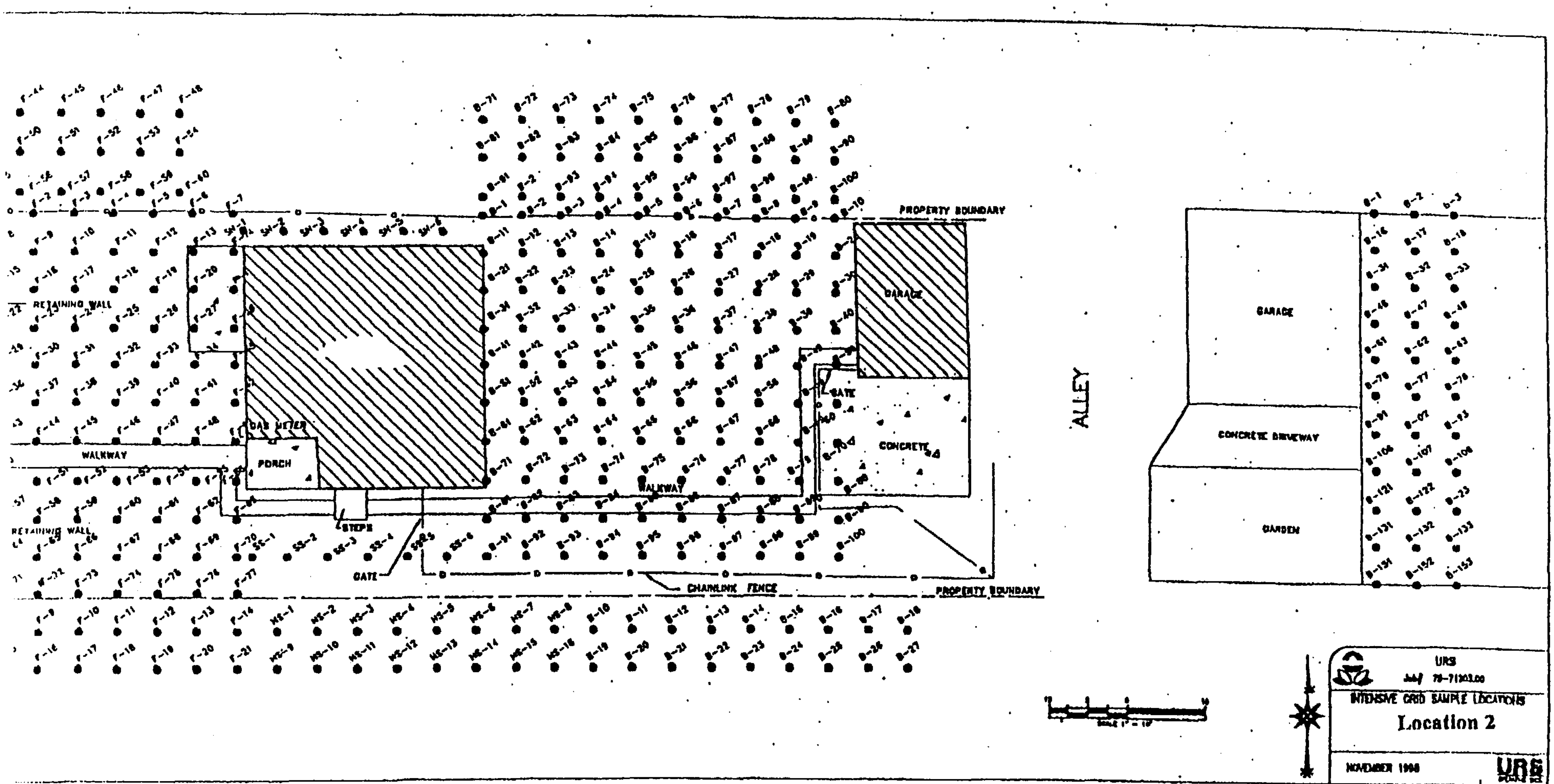
APPENDIX C

Risk Based Sampling Grids

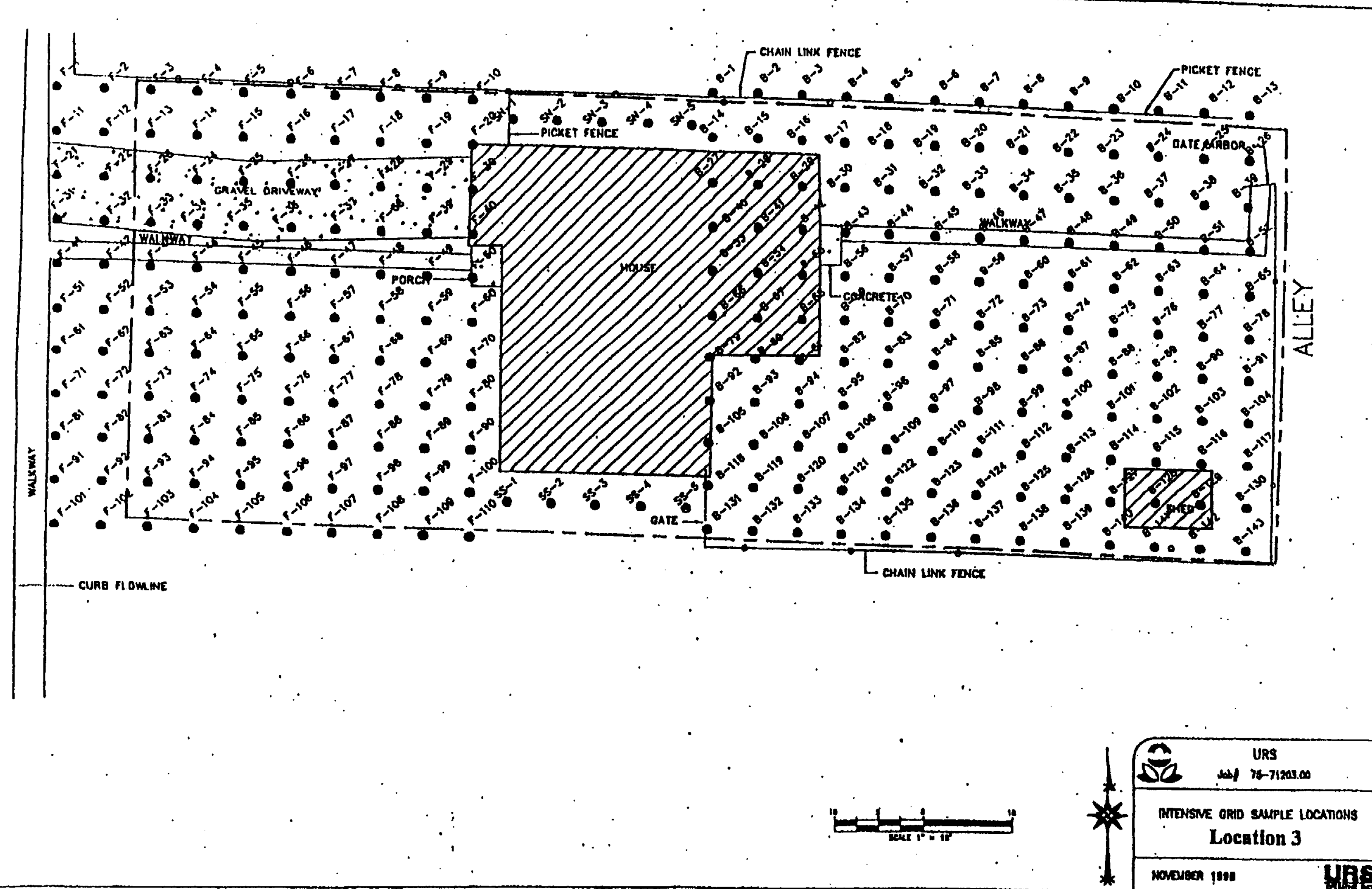
Sampling Grid for Location 1



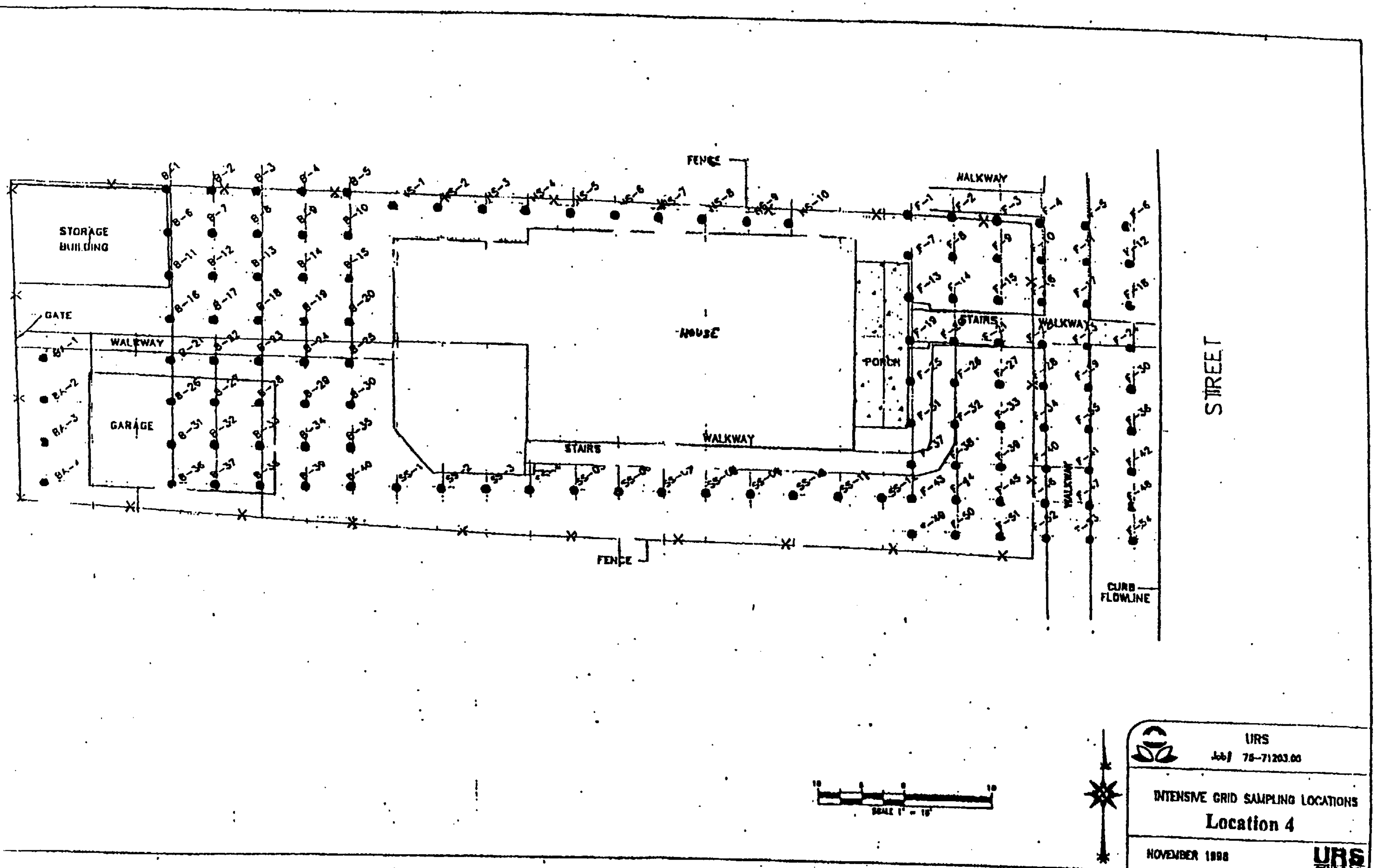
Sampling Grid for Location 2



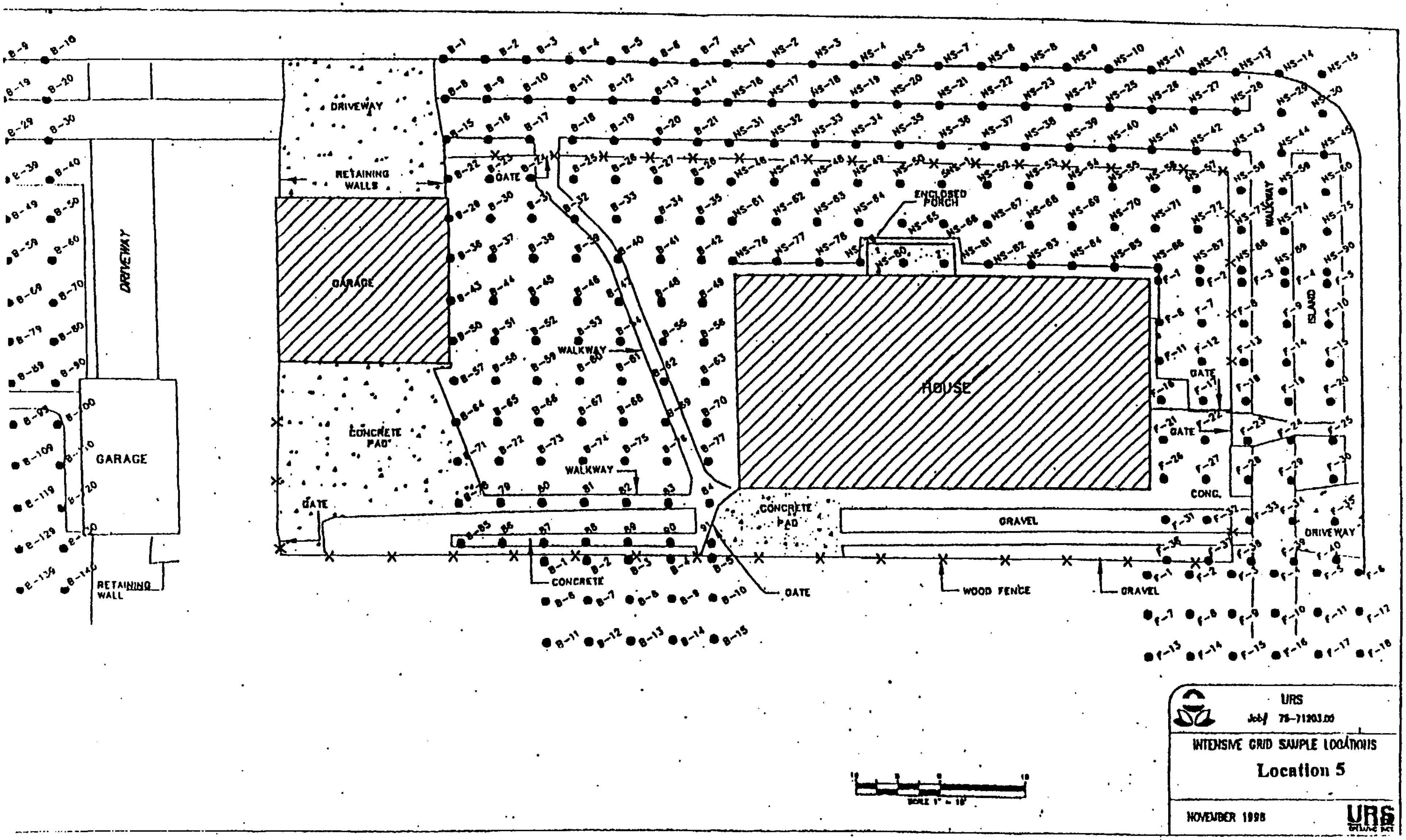
Sampling Gr[illegible]or Location 3



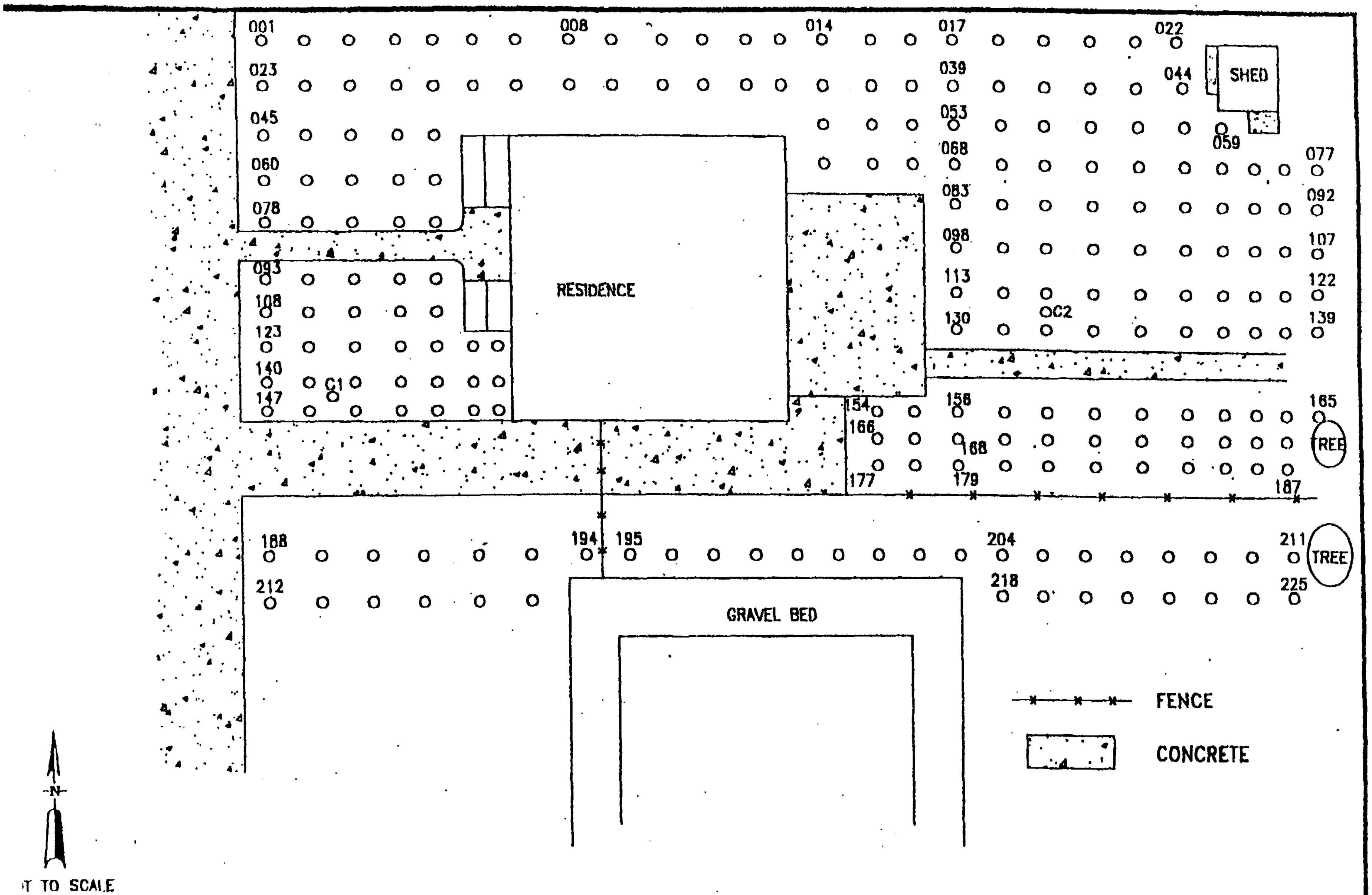
Sampling Grid for Location 4



Sampling Grid for Location 5



Sampling Grid for Location 6



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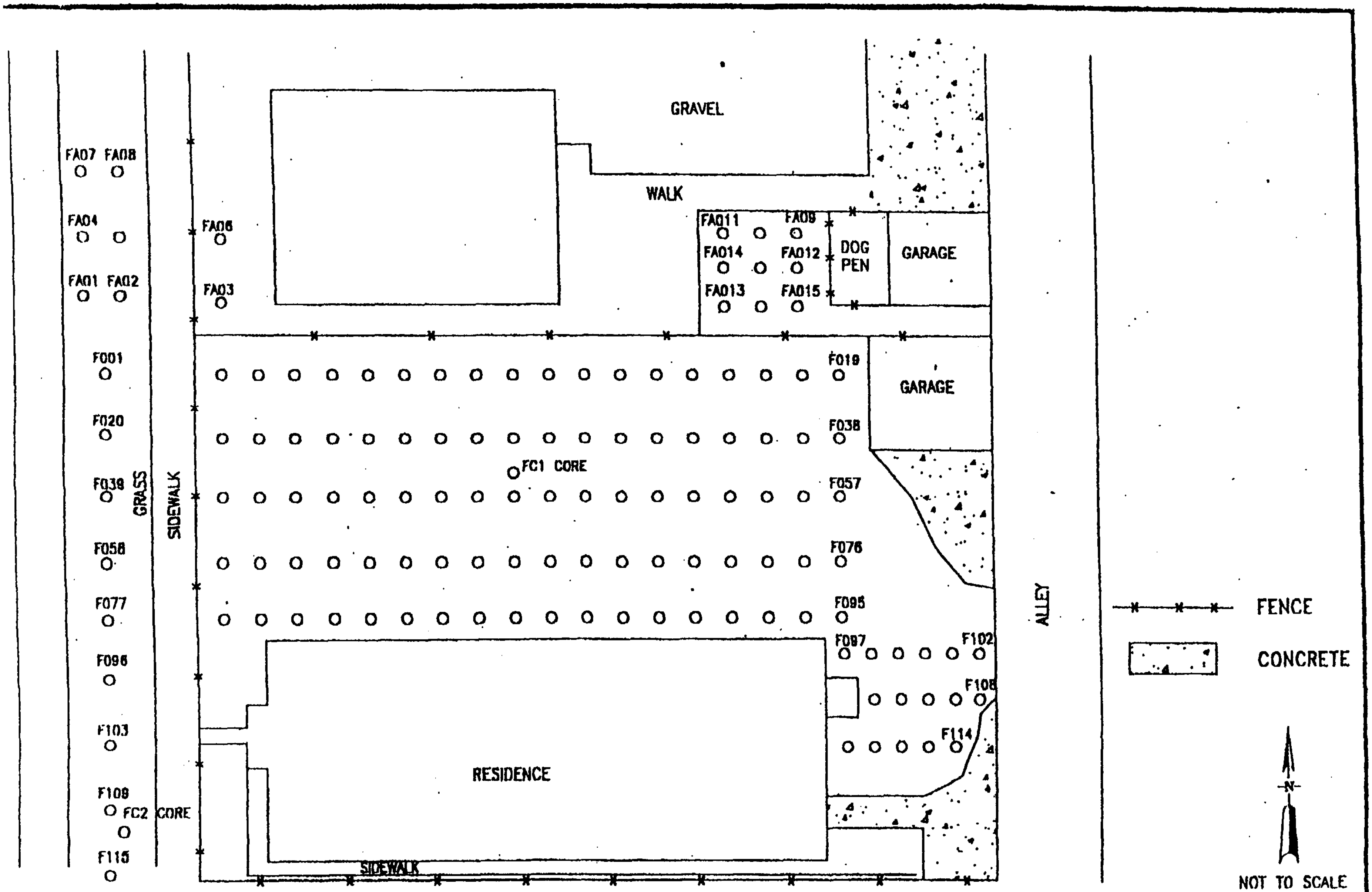
Location 6

Sampling Grid for Location 7



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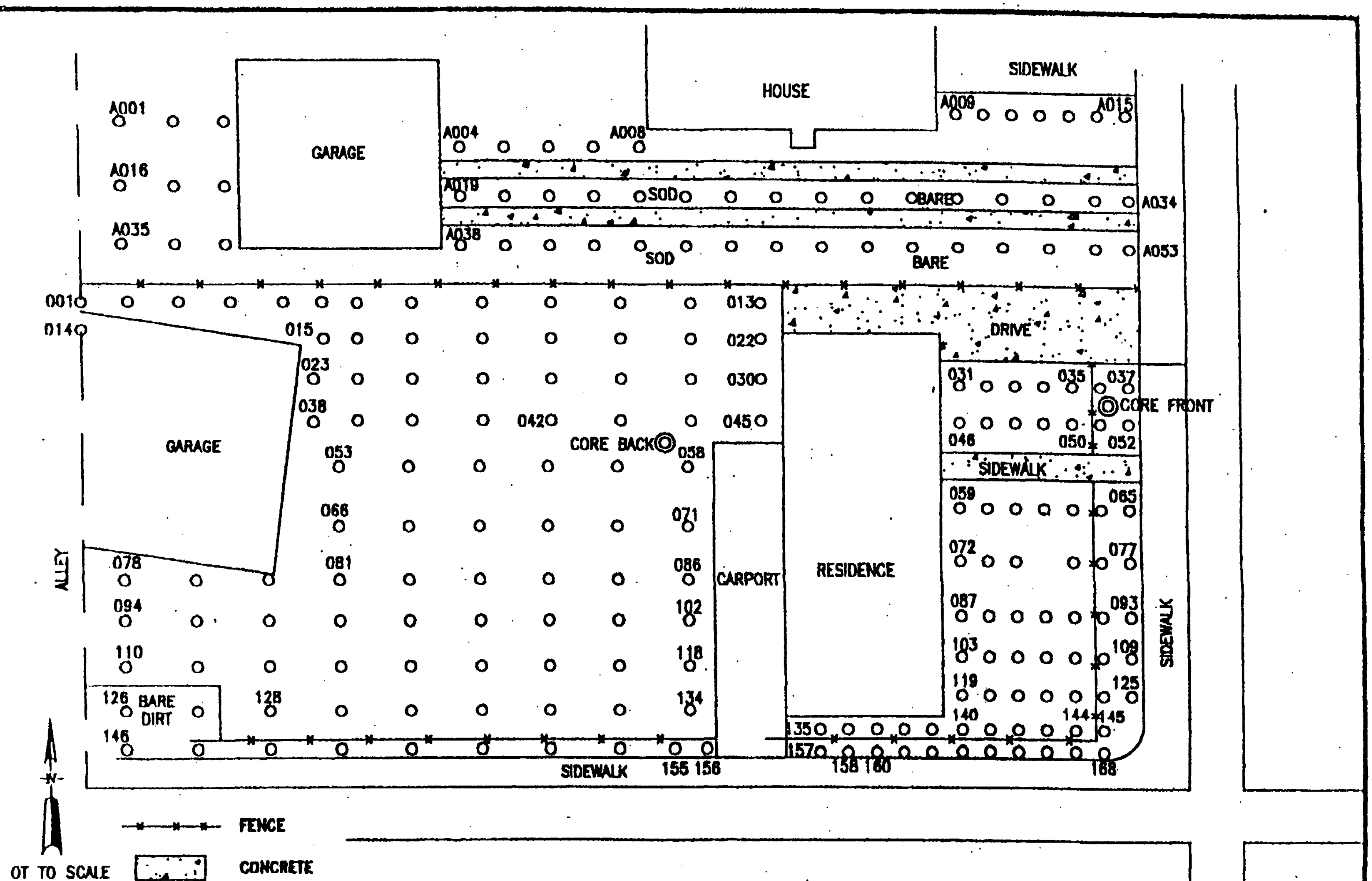
Sampling Grid for Location 8



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Location 8

APPENDIX D

Risk Based Sampling Map Coordinates and Concentration Values From 8 Residential Properties

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 1	C4701ELB-128	B-128	0.0	2.0		9	246	7	703
Map 1	C4701ELB-098	B-98	0.0	5.0	OK	87	516	9	474
Map 1	C4701ELB-088	B-88	0.0	6.0	OK	167	808	11	505
Map 1	C4701ELB-078	B-78	0.0	7.0	OK	61	634	10	381
Map 1	C4701ELB-068	B-68	0.0	8.0	OK	68	540	8	586
Map 1	C4701ELB-058	B-58	0.0	9.0	OK	97	1206	14	897
Map 1	C4701ELB-048	B-48	0.0	10.0	OK	56	1040	13	842
Map 1	C4701ELB-028	B-28	0.0	12.0	OK	122	829	9	559
Map 1	C4701ELB-018	B-18	0.0	13.0	OK	73	691	6	308
Map 1	C4701ELB-008	B-8	0.0	14.0	OK	57	280	2	408
Map 1	C4701ELB-129	B-129	1.0	2.0	OK	9	127	6	279
Map 1	C4701ELB-099	B-99	1.0	5.0	OK	9	324	8	373
Map 1	C4701ELB-089	B-89	1.0	6.0	OK	105	297	6	361
Map 1	C4701ELB-079	B-79	1.0	7.0	OK	60	567	9	392
Map 1	C4701ELB-069	B-69	1.0	8.0	OK	30	398	7	582
Map 1	C4701ELB-059	B-59	1.0	9.0	OK	9	546	6	614
Map 1	C4701ELB-049	B-49	1.0	10.0	OK	9	339	8	548
Map 1	C4701ELB-029	B-29	1.0	12.0	OK	214	2124	17	695
Map 1	C4701ELB-019	B-19	1.0	13.0	OK	21	237	5	282
Map 1	C4701ELB-009	B-9	1.0	14.0	OK	25	213	5	431
Map 1	C4701ELB-130	B-130	2.0	2.0	OK	28	132	2	354
Map 1	C4701ELB-090	B-90	2.0	6.0	OK	20	726	8	749
Map 1	C4701ELB-080	B-80	2.0	7.0	OK	80	193	5	350
Map 1	C4701ELB-070	B-70	2.0	8.0	OK	9	200	5	668
Map 1	C4701ELB-030	B-30	2.0	12.0	OK	53	482	7	687
Map 1	C4701ELB-020	B-20	2.0	13.0	OK	9	199	7	332
Map 1	C4701ELB-010	B-10	2.0	14.0	OK	52	356	6	435
Map 1	C4701THB-007	B-7	5.0	0.0	OK	9	227	2	188
Map 1	C4711THB-071	B-71	5.0	3.0	OK	27	235	7	718
Map 1	C4711THB-064	B-64	5.0	4.0	OK	52	251	5	579
Map 1	C4711THB-036	B-36	5.0	8.0	OK	43	249	5	1168
Map 1	C4711THB-029	B-29	5.0	9.0	OK	9	284	4	451
Map 1	C4711THB-022	B-22	5.0	10.0	OK	21	251	5	361
Map 1	C4711THB-015	B-15	5.0	11.0	OK	68	212	7	575
Map 1	C4711THB-008	B-8	5.0	12.0	OK	115	326	6	431
Map 1	C4711THB-001	B-1	5.0	13.0	OK	56	260	5	412
Map 1	C4721THB-109	B-109	5.0	14.0	OK	57	393	7	4383
Map 1	C4721THB-100	B-100	5.0	15.0	OK	78	229	4	171
Map 1	C4721THB-091	B-91	5.0	16.0	OK	53	177	9	210
Map 1	C4701THB-008	B-8	6.0	0.0	OK	9	481	8	336
Map 1	C4711THB-072	B-72	6.0	3.0	OK	31	221	7	256
Map 1	C4711THB-065	B-65	6.0	4.0	OK	78	270	5	246
Map 1	C4711THB-058	B-58	6.0	5.0	OK	47	276	2	308
Map 1	C4711THB-051	B-51	6.0	6.0	OK	67	299	2	293
Map 1	C4711THB-044	B-44	6.0	7.0	OK	72	330	6	389
Map 1	C4711THB-023	B-23	6.0	10.0	OK	149	473	7	347
Map 1	C4711THB-016	B-16	6.0	11.0	OK	111	277	7	369
Map 1	C4711THB-009	B-9	6.0	12.0	OK	59	239	5	245
Map 1	C4711THB-002	B-2	6.0	13.0	OK	9	235	6	241
Map 1	C4721THB-110	B-110	6.0	14.0	OK	55	221	2	306
Map 1	C4721THB-101	B-101	6.0	15.0	OK	92	171	2	163
Map 1	C4721THB-092	B-92	6.0	16.0	OK	27	83	4	137
Map 1	C4701THB-009	B-9	7.0	0.0	OK	9	413	8	314

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 1	C4711THB-073	B-73	7.0	3.0	OK	1348	1542	21	563
Map 1	C4711THB-066	B-66	7.0	4.0	OK	912	2040	17	590
Map 1	C4711THB-059	B-59	7.0	5.0	OK	678	559	8	339
Map 1	C4711THB-052	B-52	7.0	6.0	OK	4514	2171	21	800
Map 1	C4711THB-045	B-45	7.0	7.0	OK	622	572	9	337
Map 1	C4711THB-024	B-24	7.0	10.0	OK	198	463	6	261
Map 1	C4711THB-017	B-17	7.0	11.0	OK	460	404	8	272
Map 1	C4711THB-010	B-10	7.0	12.0	OK	124	643	6	385
Map 1	C4711THB-003	B-3	7.0	13.0	OK	277	1503	10	416
Map 1	C4721THB-111	B-111	7.0	14.0	OK	89	281	6	2417
Map 1	C4721THB-102	B-102	7.0	15.0	OK	98	221	2	164
Map 1	C4721THB-093	B-93	7.0	16.0	OK	88	308	4	147
Map 1	C4701THN-021	SN-21	8.0	0.0	OK	102	955	12	897
Map 1	C4701THN-011	SN-11	8.0	1.0	OK	104	354	8	811
Map 1	C4701THN-001	SN-1	8.0	2.0	OK	60	254	7	602
Map 1	C4711THB-074	B-74	8.0	3.0	OK	591	1533	11	458
Map 1	C4711THB-067	B-67	8.0	4.0	OK	256	864	10	290
Map 1	C4711THB-060	B-60	8.0	5.0	OK	2177	2427	22	741
Map 1	C4711THB-053	B-53	8.0	6.0	OK	887	1236	10	489
Map 1	C4711THB-046	B-46	8.0	7.0	OK	1160	833	7	338
Map 1	C4711THB-039	B-39	8.0	8.0	OK	264	515	9	306
Map 1	C4711THB-032	B-32	8.0	9.0	OK	678	835	12	311
Map 1	C4711THB-025	B-25	8.0	10.0	OK	373	559	10	310
Map 1	C4711THB-018	B-18	8.0	11.0	OK	988	986	14	482
Map 1	C4721THB-112	B-112	8.0	14.0	OK	195	517	6	827
Map 1	C4721THB-103	B-103	8.0	15.0	OK	387	1484	6	203
Map 1	C4721THB-094	B-94	8.0	16.0	OK	166	393	6	164
Map 1	C4701THN-022	SN-22	9.0	0.0	OK	47	408	9	703
Map 1	C4701THN-012	SN-12	9.0	1.0	OK	9	367	6	404
Map 1	C4701THN-002	SN-2	9.0	2.0	OK	9	187	7	501
Map 1	C4711THB-075	B-75	9.0	3.0	OK	1500	2783	21	846
Map 1	C4711THB-068	B-68	9.0	4.0	OK	1434	2783	18	482
Map 1	C4711THB-061	B-61	9.0	5.0	OK	2426	1993	23	548
Map 1	C4711THB-054	B-54	9.0	6.0	OK	2848	2991	27	722
Map 1	C4711THB-047	B-47	9.0	7.0	OK	846	2783	18	501
Map 1	C4711THB-040	B-40	9.0	8.0	OK	1700	2589	19	807
Map 1	C4711THB-033	B-33	9.0	9.0	OK	540	773	9	392
Map 1	C4711THB-026	B-26	9.0	10.0	OK	851	2792	10	489
Map 1	C4711THB-019	B-19	9.0	11.0	OK	409	553	9	270
Map 1	C4721THB-113	B-113	9.0	14.0	OK	175	1145	8	513
Map 1	C4721THB-104	B-104	9.0	15.0	OK	148	592	6	183
Map 1	C4721THB-095	B-95	9.0	16.0	OK	96	588	8	204
Map 1	C4701THN-023	SN-23	10.0	0.0	OK	9	758	8	249
Map 1	C4701THN-013	SN-13	10.0	1.0	OK	9	316	6	120
Map 1	C4701THN-003	SN-3	10.0	2.0	OK	26	302	8	520
Map 1	C4711THB-076	B-76	10.0	3.0	OK	704	2580	24	722
Map 1	C4711THB-069	B-69	10.0	4.0	OK	1242	2844	18	478
Map 1	C4711THB-062	B-62	10.0	5.0	OK	2362	1756	12	470
Map 1	C4711THB-055	B-55	10.0	6.0	OK	1972	1736	17	656
Map 1	C4711THB-048	B-48	10.0	7.0	OK	494	1175	17	517
Map 1	C4711THB-041	B-41	10.0	8.0	OK	326	927	8	308
Map 1	C4711THB-034	B-34	10.0	9.0	OK	1267	2143	18	741
Map 1	C4711THB-027	B-27	10.0	10.0	OK	1282	2939	17	509

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord		Concentration (ppm)			
						As	Pb	Cd	Zn
Map 1	C4711THB-020	B-20	10.0	11.0	OK	877	675	10	350
Map 1	C4711THB-013	B-13	10.0	12.0	OK	831	1581	11	337
Map 1	C4711THB-006	B-6	10.0	13.0	OK	775	624	13	313
Map 1	C4721THB-114	B-114	10.0	14.0	OK	111	430	7	772
Map 1	C4721THB-105	B-105	10.0	15.0	OK	122	516	8	173
Map 1	C4721THB-096	B-96	10.0	16.0	OK	97	440	9	180
Map 1	C4701THN-024	SN-24	11.0	0.0	OK	39	214	6	297
Map 1	C4701THN-014	SN-14	11.0	1.0	OK	38	386	5	466
Map 1	C4701THN-004	SN-4	11.0	2.0	OK	50	257	7	827
Map 1	C4711THB-077	B-77	11.0	3.0	OK	887	2327	15	501
Map 1	C4711THB-070	B-70	11.0	4.0	OK	1282	1851	15	489
Map 1	C4711THB-063	B-63	11.0	5.0	OK	912	2078	14	486
Map 1	C4711THB-056	B-56	11.0	6.0	OK	2625	3202	18	486
Map 1	C4711THB-049	B-49	11.0	7.0	OK	1454	2651	20	517
Map 1	C4711THB-042	B-42	11.0	8.0	OK	1691	3955	15	478
Map 1	C4711THB-035	B-35	11.0	9.0	OK	2615	2957	16	582
Map 1	C4711THB-028	B-28	11.0	10.0	OK	187	1581	13	323
Map 1	C4711THB-014	B-14	11.0	11.0	OK	1565	1975	10	528
Map 1	C4711THB-021	B-21	11.0	12.0	OK	566	765	10	458
Map 1	C4711THB-007	B-7	11.0	13.0	OK	448	752	9	297
Map 1	C4721THB-115	B-115	11.0	14.0	OK	143	587	5	672
Map 1	C4721THB-106	B-106	11.0	15.0	OK	55	353	6	147
Map 1	C4721THB-097	B-97	11.0	16.0	OK	83	364	4	141
Map 1	C4711THN-001	SN-1	11.5	13.0	OK	510	976	12	299
Map 1	C4701THN-025	SN-25	12.0	0.0	OK	9	230	6	264
Map 1	C4701THN-015	SN-15	12.0	1.0	OK	53	177	6	337
Map 1	C4701THN-005	SN-5	12.0	2.0	OK	1029	610	19	6903
Map 1	C4711THS-008	SS-8	12.0	3.0	OK	245	1021	8	278
Map 1	C4711THS-001	SS-1	12.0	4.0	OK	360	1185	12	317
Map 1	C4721THB-116	B-116	12.0	14.0	OK	9	299	7	1439
Map 1	C4721THB-107	B-107	12.0	15.0	OK	164	663	8	204
Map 1	C4721THB-098	B-98	12.0	16.0	OK	64	451	8	162
Map 1	C4711THN-002	SN-2	12.5	13.0	OK	658	1074	11	369
Map 1	C4701THN-026	SN-26	13.0	0.0	OK	38	241	7	239
Map 1	C4701THN-016	SN-16	13.0	1.0	OK	59	356	7	423
Map 1	C4701THN-006	SN-6	13.0	2.0	OK	20	681	13	1381
Map 1	C4711THS-009	SS-9	13.0	3.0	OK	515	2115	13	361
Map 1	C4711THS-002	SS-2	13.0	4.0	OK	445	1756	12	358
Map 1	C4721THB-117	B-117	13.0	14.0	OK	40	226	6	1447
Map 1	C4721THB-108	B-108	13.0	15.0	OK	69	2553	15	349
Map 1	C4721THB-099	B-99	13.0	16.0	OK	234	1276	6	208
Map 1	C4721THS-013	S-13	13.3	14.0	OK	197	366	8	4111
Map 1	C4721THS-007	S-7	13.3	15.0	OK	9	179	4	315
Map 1	C4721THS-001	S-1	13.3	16.0	OK	37	293	9	1160
Map 1	C4711THN-003	SN-3	13.5	13.0	OK	1464	1984	15	544
Map 1	C4701THN-007	SN-7	14.0	2.0	OK	108	323	8	652
Map 1	C4701THN-017	SN-17	14.0	1.0	OK	55	1425	14	920
Map 1	C4711THS-010	SS-10	14.0	3.0	OK	958	1185	16	458
Map 1	C4711THS-003	SS-3	14.0	4.0	OK	1972	2473	18	505
Map 1	C4721THS-014	S-14	14.2	14.0	OK	233	1054	10	869
Map 1	C4721THS-008	S-8	14.2	15.0	OK	35	644	6	214
Map 1	C4721THS-002	S-2	14.2	16.0	OK	43	233	5	266
Map 1	C4711THN-004	SN-4	14.5	13.0	OK	2610	3093	28	800

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 1	C4701THN-018	SN-18	15.0	1.0	OK	63	399	9	497
Map 1	C4701THN-008	SN-8	15.0	2.0	OK	255	352	10	1098
Map 1	C4711THS-011	SS-11	15.0	3.0	OK	1736	1266	11	339
Map 1	C4711THS-004	SS-4	15.0	4.0	OK	2027	2642	17	474
Map 1	C4721THS-015	S-15	15.1	14.0	OK	800	881	11	974
Map 1	C4721THS-009	S-9	15.1	15.0	OK	139	888	8	244
Map 1	C4721THS-003	S-3	15.1	16.0	OK	9	253	6	225
Map 1	C4711THN-005	SN-5	15.5	13.0	OK	1247	2282	20	455
Map 1	C4701THN-019	SN-19	16.0	1.0	OK	241	1246	11	1831
Map 1	C4701THN-009	SN-9	16.0	2.0	OK	109	305	10	641
Map 1	C4711THS-012	SS-12	16.0	3.0	OK	2007	1804	16	431
Map 1	C4711THS-005	SS-5	16.0	4.0	OK	1445	1784	17	544
Map 1	C4721THS-016	S-16	16.0	14.0	OK	265	676	9	815
Map 1	C4721THS-010	S-10	16.0	15.0	OK	82	958	10	264
Map 1	C4721THS-004	S-4	16.0	16.0	OK	62	274	2	259
Map 1	C4711THN-006	SN-6	16.5	13.0	OK	2496	2914	25	866
Map 1	C4701THN-020	SN-20	17.0	1.0	OK	23	702	10	959
Map 1	C4701THN-010	SN-10	17.0	2.0	OK	39	413	10	1614
Map 1	C4711THS-013	SS-13	17.0	3.0	OK	988	1405	7	318
Map 1	C4711THS-006	SS-6	17.0	4.0	OK	698	1794	15	532
Map 1	C4721THS-017	S-17	17.0	14.0	OK	550	762	6	916
Map 1	C4721THS-011	S-11	17.0	15.0	OK	96	884	9	237
Map 1	C4721THS-005	S-5	17.0	16.0	OK	66	439	8	317
Map 1	C4711THN-007	SN-7	17.5	13.0	OK	1842	1484	15	474
Map 1	C4711THS-014	SS-14	17.5	3.0	OK	170	353	5	1288
Map 1	C4711THS-007	SS-7	17.5	4.0	OK	2714	454	7	505
Map 1	C4721THS-018	S-18	18.0	14.0	OK	704	1345	10	835
Map 1	C4701THF-009	F-9	18.0	1.0	OK	63	317	11	532
Map 1	C4701THF-001	F-1	18.0	2.0	OK	53	394	10	1629
Map 1	C4711THF-078	F-78	18.0	3.0	OK	128	316	4	299
Map 1	C4711THF-071	F-71	18.0	4.0	OK	109	460	5	299
Map 1	C4711THF-050	F-50	18.0	7.0	OK	134	413	8	273
Map 1	C4711THF-008	F-8	18.0	13.0	OK	2912	628	9	4693
Map 1	C4711THF-001	F-1	18.0	14.0	OK	3105	929	12	5003
Map 1	C4721THS-012	S-12	18.0	15.0	OK	111	1115	10	385
Map 1	C4721THS-006	S-6	18.0	16.0	OK	9	560	11	1637
Map 1	C4721THF-071	F-71	18.3	15.0	OK	178	905	8	180
Map 1	C4721THF-064	F-64	18.3	16.0	OK	109	626	7	228
Map 1	C4701THF-018	F-18	19.0	0.0	OK	123	434	9	223
Map 1	C4701THF-010	F-10	19.0	1.0	OK	59	734	7	350
Map 1	C4701THF-002	F-2	19.0	2.0	OK	24	363	8	524
Map 1	C4711THF-079	F-79	19.0	3.0	OK	831	2870	13	400
Map 1	C4711THF-072	F-72	19.0	4.0	OK	2526	2580	16	575
Map 1	C4711THF-065	F-65	19.0	5.0	OK	1272	1523	13	299
Map 1	C4711THF-058	F-58	19.0	6.0	OK	1348	2263	14	586
Map 1	C4711THF-051	F-51	19.0	7.0	OK	1610	1395	11	339
Map 1	C4711THF-044	F-44	19.0	8.0	OK	1786	1601	14	451
Map 1	C4711THF-037	F-37	19.0	9.0	OK	1298	3160	13	486
Map 1	C4711THF-016	F-16	19.0	12.0	OK	198	606	9	1083
Map 1	C4711THF-009	F-9	19.0	13.0	OK	1676	4829	15	520
Map 1	C4711THF-002	F-2	19.0	14.0	OK	1414	4225	11	369
Map 1	C4721THF-072	F-72	19.0	15.0	OK	160	827	14	180
Map 1	C4721THF-065	F-65	19.0	16.0	OK	65	926	9	177

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 1	C4701THF-019	F-19	20.0	0.0	OK	274	299	6	186
Map 1	C4701THF-011	F-11	20.0	1.0	OK	132	338	7	207
Map 1	C4701THF-003	F-3	20.0	2.0	OK	57	305	9	1397
Map 1	C4711THF-080	F-80	20.0	3.0	OK	1039	2482	14	447
Map 1	C4711THF-073	F-73	20.0	4.0	OK	342	1064	11	400
Map 1	C4711THF-066	F-66	20.0	5.0	OK	540	1454	9	373
Map 1	C4711THF-059	F-59	20.0	6.0	OK	765	1727	16	385
Map 1	C4711THF-052	F-52	20.0	7.0	OK	749	1993	12	277
Map 1	C4711THF-045	F-45	20.0	8.0	OK	719	2189	9	278
Map 1	C4711THF-038	F-38	20.0	9.0	OK	499	1861	15	509
Map 1	C4711THF-017	F-17	20.0	12.0	OK	1262	2669	19	497
Map 1	C4711THF-010	F-10	20.0	13.0	OK	454	2382	9	354
Map 1	C4711THF-003	F-3	20.0	14.0	OK	408	1474	9	269
Map 1	C4721THF-073	F-73	20.0	15.0	OK	108	544	7	141
Map 1	C4721THF-066	F-66	20.0	16.0	OK	978	2809	12	227
Map 1	C4701THF-020	F-20	21.0	0.0	OK	69	338	5	240
Map 1	C4701THF-012	F-12	21.0	1.0	OK	9	307	8	226
Map 1	C4701THF-004	F-4	21.0	2.0	OK	40	290	7	660
Map 1	C4711THF-081	F-81	21.0	3.0	OK	698	2455	13	273
Map 1	C4711THF-074	F-74	21.0	4.0	OK	602	1591	14	354
Map 1	C4711THF-067	F-67	21.0	5.0	OK	1293	2152	15	392
Map 1	C4711THF-060	F-60	21.0	6.0	OK	1222	3924	15	486
Map 1	C4711THF-053	F-53	21.0	7.0	OK	1257	3227	20	637
Map 1	C4711THF-046	F-46	21.0	8.0	OK	1902	3093	12	466
Map 1	C4711THF-039	F-39	21.0	9.0	OK	1277	3651	15	478
Map 1	C4711THF-018	F-18	21.0	12.0	OK	938	2427	15	439
Map 1	C4711THF-011	F-11	21.0	13.0	OK	282	1115	11	246
Map 1	C4711THF-004	F-4	21.0	14.0	OK	770	2309	10	323
Map 1	C4721THF-074	F-74	21.0	15.0	OK	140	555	8	150
Map 1	C4721THF-067	F-67	21.0	16.0	OK	187	1698	8	176
Map 1	C4701THF-021	F-21	22.0	0.0	OK	197	195	5	203
Map 1	C4701THF-013	F-13	22.0	1.0	OK	82	216	8	189
Map 1	C4701THF-005	F-5	22.0	2.0	OK	104	263	10	846
Map 1	C4711THF-082	F-82	22.0	3.0	OK	683	1659	11	296
Map 1	C4711THF-075	F-75	22.0	4.0	OK	1741	2818	23	699
Map 1	C4711THF-068	F-68	22.0	5.0	OK	1156	2199	19	497
Map 1	C4711THF-061	F-61	22.0	6.0	OK	744	2152	16	435
Map 1	C4711THF-054	F-54	22.0	7.0	OK	892	2097	11	427
Map 1	C4711THF-047	F-47	22.0	8.0	OK	1686	2254	15	524
Map 1	C4711THF-040	F-40	22.0	9.0	OK	1368	4816	14	602
Map 1	C4711THF-019	F-19	22.0	12.0	OK	912	1823	15	455
Map 1	C4711THF-012	F-12	22.0	13.0	OK	591	1105	9	259
Map 1	C4711THF-005	F-5	22.0	14.0	OK	953	2050	15	286
Map 1	C4721THF-075	F-75	22.0	15.0	OK	145	664	7	292
Map 1	C4721THF-068	F-68	22.0	16.0	OK	93	566	7	138
Map 1	C4701THF-022	F-22	23.0	0.0	OK	42	125	2	139
Map 1	C4701THF-014	F-14	23.0	1.0	OK	31	153	2	173
Map 1	C4701THF-006	F-6	23.0	2.0	OK	161	352	11	1059
Map 1	C4711THF-083	F-83	23.0	3.0	OK	1014	2162	11	358
Map 1	C4711THF-076	F-76	23.0	4.0	OK	1464	1620	14	361
Map 1	C4711THF-069	F-69	23.0	5.0	OK	1049	1601	13	286
Map 1	C4711THF-062	F-62	23.0	6.0	OK	1115	1581	12	358
Map 1	C4711THF-055	F-55	23.0	7.0	OK	1100	1640	11	276

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 1	C4711THF-048	F-48	23.0	8.0	OK	704	1552	8	304
Map 1	C4711THF-041	F-41	23.0	9.0	OK	1207	1765	8	275
Map 1	C4711THF-020	F-20	23.0	12.0	OK	872	1775	14	361
Map 1	C4711THF-013	F-13	23.0	13.0	OK	1459	3118	17	334
Map 1	C4711THF-006	F-6	23.0	14.0	OK	2127	3101	10	314
Map 1	C4721THF-069	F-69	23.0	16.0	OK	208	2957	8	254
Map 1	C4701THF-023	F-23	24.0	0.0	OK	9	111	4	141
Map 1	C4701THF-015	F-15	24.0	1.0	OK	9	295	5	344
Map 1	C4701THF-007	F-7	24.0	2.0	OK	53	383	8	276
Map 1	C4711THF-084	F-84	24.0	3.0	OK	239	508	8	216
Map 1	C4711THF-077	F-77	24.0	4.0	OK	902	620	8	225
Map 1	C4711THF-070	F-70	24.0	5.0	OK	104	355	9	241
Map 1	C4711THF-063	F-63	24.0	6.0	OK	26	311	8	260
Map 1	C4711THF-056	F-56	24.0	7.0	OK	405	474	7	231
Map 1	C4711THF-049	F-49	24.0	8.0	OK	343	348	5	159
Map 1	C4711THF-042	F-42	24.0	9.0	OK	486	425	9	199
Map 1	C4711THF-021	F-21	24.0	12.0	OK	277	418	6	180
Map 1	C4711THF-014	F-14	24.0	13.0	OK	535	460	8	247
Map 1	C4711THF-007	F-7	24.0	14.0	OK	339	1064	7	209
Map 1	C4721THF-077	F-77	24.0	15.0	OK	21	878	9	232
Map 1	C4721THF-070	F-70	24.0	16.0	OK	145	1474	10	262
Map 1	C4701THF-024	F-24	25.0	0.0	OK	9	270	4	182
Map 1	C4701THF-016	F-16	25.0	1.0	OK	66	326	6	211
Map 1	C4701THF-008	F-8	25.0	2.0	OK	153	383	9	249
Map 1	None	F-78			OK	877	3017	17	344
Map 1	None	F-79				1897	3855	22	373
Map 1	None	F-80				831	1533	13	202
Map 1	None	F-81				831	1650	12	209
Map 1	None	F-82				2977	5223	19	392
Map 1	None	F-83				2561	5097	16	281
Map 1	None	F-84				52	398	7	245
Map 1						155	1562	11	197
Map 2	C4680CYF-015	F-15	0.0	0.0		68	232	7	119
Map 2	C4680CYF-008	F-8	0.0	1.0	OK	54	268	5	133
Map 2	C4690CYF-071	F-71	0.0	2.0	OK	336	878	7	185
Map 2	C4690CYF-064	F-64	0.0	3.0	OK	907	1474	8	252
Map 2	C4690CYF-057	F-57	0.0	4.0	OK	499	961	10	192
Map 2	C4690CYF-050	F-50	0.0	5.0	OK	591	623	11	190
Map 2	C4690CYF-043	F-43	0.0	6.0	OK	299	499	8	188
Map 2	C4690CYF-036	F-36	0.0	7.0	OK	318	1105	9	171
Map 2	C4690CYF-029	F-29	0.0	8.0	OK	1141	566	6	183
Map 2	C4690CYF-022	F-22	0.0	9.0	OK	438	410	6	204
Map 2	C4690CYF-015	F-15	0.0	10.0	OK	1726	1028	5	157
Map 2	C4690CYF-008	F-8	0.0	11.0	OK	1489	648	7	182
Map 2	C4690CYF-001	F-1	0.0	12.0	OK	1156	554	8	155
Map 2	C4694CYF-055	F-55	0.0	13.0	OK	26	82	2	95
Map 2	C4694CYF-049	F-49	0.0	14.0	OK	9	30	2	54
Map 2	C4694CYF-043	F-43	0.0	15.0	OK	66	30	2	60
Map 2	C4680CYF-016	F-16	1.0	0.0	OK	98	334	6	199
Map 2	C4680CYF-009	F-9	1.0	1.0	OK	51	339	4	172
Map 2	C4690CYF-072	F-72	1.0	2.0	OK	515	2346	12	350
Map 2	C4690CYF-065	F-65	1.0	3.0	OK	816	840	10	166
Map 2	C4690CYF-058	F-58	1.0	4.0	OK	1967	1542	12	305

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 2	C4690CYF-051	F-51	1.0	5.0	OK	1932	1804	11	245
Map 2	C4690CYF-044	F-44	1.0	6.0	OK	2037	1552	12	291
Map 2	C4690CYF-037	F-37	1.0	7.0	OK	90	67	2	48
Map 2	C4690CYF-030	F-30	1.0	8.0	OK	1666	586	8	229
Map 2	C4690CYF-023	F-23	1.0	9.0	OK	7810	2031	14	219
Map 2	C4690CYF-016	F-16	1.0	10.0	OK	3449	2473	10	232
Map 2	C4690CYF-009	F-9	1.0	11.0	OK	1716	1135	14	168
Map 2	C4690CYF-002	F-2	1.0	12.0	OK	6374	1385	13	311
Map 2	C4694CYF-056	F-56	1.0	13.0	OK	81	324	7	177
Map 2	C4694CYF-050	F-50	1.0	14.0	OK	9	293	7	199
Map 2	C4694CYF-044	F-44	1.0	15.0	OK	9	197	4	159
Map 2	C4680CYF-017	F-17	2.0	0.0	OK	439	2562	13	385
Map 2	C4680CYF-010	F-10	2.0	1.0	OK	140	965	13	248
Map 2	C4690CYF-073	F-73	2.0	2.0	OK	247	2124	13	266
Map 2	C4690CYF-066	F-66	2.0	3.0	OK	1429	2427	11	200
Map 2	C4690CYF-059	F-59	2.0	4.0	OK	1822	1375	14	226
Map 2	C4690CYF-052	F-52	2.0	5.0	OK	2625	1256	12	269
Map 2	C4690CYF-045	F-45	2.0	6.0	OK	1348	866	9	213
Map 2	C4690CYF-038	F-38	2.0	7.0	OK	1721	457	10	206
Map 2	C4690CYF-031	F-31	2.0	8.0	OK	332	315	9	294
Map 2	C4690CYF-024	F-24	2.0	9.0	OK	581	354	7	215
Map 2	C4690CYF-017	F-17	2.0	10.0	OK	2719	874	10	198
Map 2	C4690CYF-010	F-10	2.0	11.0	OK	3208	3135	12	300
Map 2	C4690CYF-003	F-3	2.0	12.0	OK	4219	1899	15	292
Map 2	C4694CYF-057	F-57	2.0	13.0	OK	64	303	7	162
Map 2	C4694CYF-051	F-51	2.0	14.0	OK	9	195	5	125
Map 2	C4694CYF-045	F-45	2.0	15.0	OK	46	171	5	131
Map 2	C4680CYF-018	F-18	3.0	0.0	OK	9	453	9	206
Map 2	C4680CYF-011	F-11	3.0	1.0	OK	92	1135	12	266
Map 2	C4690CYF-074	F-74	3.0	2.0	OK	460	2731	13	245
Map 2	C4690CYF-067	F-67	3.0	3.0	OK	3193	3127	12	291
Map 2	C4690CYF-060	F-60	3.0	4.0	OK	973	595	7	263
Map 2	C4690CYF-053	F-53	3.0	5.0	OK	3055	2853	17	365
Map 2	C4690CYF-046	F-46	3.0	6.0	OK	2317	1746	10	295
Map 2	C4690CYF-039	F-39	3.0	7.0	OK	3542	1899	15	285
Map 2	C4690CYF-032	F-32	3.0	8.0	OK	2421	1717	13	265
Map 2	C4690CYF-025	F-25	3.0	9.0	OK	2252	688	9	226
Map 2	C4690CYF-018	F-18	3.0	10.0	OK	1917	1365	14	190
Map 2	C4690CYF-011	F-11	3.0	11.0	OK	1676	2598	8	177
Map 2	C4690CYF-004	F-4	3.0	12.0	OK	1409	1581	12	256
Map 2	C4694CYF-058	F-58	3.0	13.0	OK	50	255	6	183
Map 2	C4694CYF-052	F-52	3.0	14.0	OK	32	244	2	121
Map 2	C4694CYF-046	F-46	3.0	15.0	OK	41	202	6	149
Map 2	C4680CYF-019	F-19	4.0	0.0	OK	83	1552	14	316
Map 2	C4690CYF-075	F-75	4.0	2.0	OK	365	2535	17	232
Map 2	C4690CYF-068	F-68	4.0	3.0	OK	1237	1464	12	161
Map 2	C4690CYF-061	F-61	4.0	4.0	OK	2167	1335	12	223
Map 2	C4690CYF-054	F-54	4.0	5.0	OK	545	386	8	308
Map 2	C4690CYF-047	F-47	4.0	6.0	OK	2217	1746	14	285
Map 2	C4690CYF-040	F-40	4.0	7.0	OK	3434	2491	18	253
Map 2	C4690CYF-033	F-33	4.0	8.0	OK	3213	1226	12	195
Map 2	C4690CYF-026	F-26	4.0	9.0	OK	3311	2031	14	232
Map 2	C4690CYF-019	F-19	4.0	10.0	OK	2486	1861	12	251

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 2	C4690CYF-012	F-12	4.0	11.0	OK	2032	2171	12	203
Map 2	C4690CYF-005	F-5	4.0	12.0	OK	2665	2309	16	263
Map 2	C4694CYF-059	F-59	4.0	13.0	OK	70	176	5	149
Map 2	C4694CYF-053	F-53	4.0	14.0	OK	9	250	5	165
Map 2	C4694CYF-047	F-47	4.0	15.0	OK	20	215	5	173
Map 2	C4680CYF-020	F-20	5.0	0.0	OK	185	1276	17	334
Map 2	C4680CYF-013	F-13	5.0	1.0	OK	138	486	10	275
Map 2	C4690CYF-076	F-76	5.0	2.0	OK	765	2069	13	205
Map 2	C4690CYF-069	F-69	5.0	3.0	OK	821	526	11	447
Map 2	C4690CYF-062	F-62	5.0	4.0	OK	5429	1804	10	365
Map 2	C4690CYF-055	F-55	5.0	5.0	OK	3698	2282	20	412
Map 2	C4690CYF-048	F-48	5.0	6.0	OK	1545	1727	11	228
Map 2	C4690CYF-041	F-41	5.0	7.0	OK	4340	1717	14	341
Map 2	C4690CYF-034	F-34	5.0	8.0	OK	1257	622	7	235
Map 2	C4690CYF-027	F-27	5.0	9.0	OK	5714	1591	10	220
Map 2	C4690CYF-020	F-20	5.0	10.0	OK	5382	3085	19	273
Map 2	C4690CYF-013	F-13	5.0	11.0	OK	335	559	7	122
Map 2	C4690CYF-006	F-6	5.0	12.0	OK	1962	1736	11	656
Map 2	C4694CYF-060	F-60	5.0	13.0	OK	22	189	4	137
Map 2	C4694CYF-054	F-54	5.0	14.0	OK	27	209	6	142
Map 2	C4694CYF-048	F-48	5.0	15.0	OK	51	189	5	161
Map 2	C4680CYF-021	F-21	6.0	0.0	OK	85	1206	16	458
Map 2	C4680CYF-014	F-14	6.0	1.0	OK	77	1562	14	305
Map 2	C4690CYF-077	F-77	6.0	2.0	OK	184	99	6	66
Map 2	C4690CYF-070	F-70	6.0	3.0	OK	958	440	6	223
Map 2	C4690CYF-063	F-63	6.0	4.0	OK	3262	1276	8	227
Map 2	C4690CYF-056	F-56	6.0	5.0	OK	3026	838	12	497
Map 2	C4690CYF-049	F-49	6.0	6.0	OK	4952	2974	13	385
Map 2	C4690CYF-042	F-42	6.0	7.0	OK	632	426	10	404
Map 2	C4690CYF-035	F-35	6.0	8.0	OK	222	356	5	197
Map 2	C4690CYF-028	F-28	6.0	9.0	OK	268	557	8	474
Map 2	C4690CYF-021	F-21	6.0	10.0	OK	698	629	9	652
Map 2	C4690CYF-014	F-14	6.0	11.0	OK	6887	4889	18	365
Map 2	C4690CYN-001	NS-1	6.0	11.5	OK	11742	2031	21	532
Map 2	C4690CYF-007	F-7	6.0	12.0	OK	4316	1572	11	296
Map 2	C4690CYS-001	SS-1	6.2	3.0	OK	4142	2391	10	333
Map 2	C4680CYN-001	NS-1	7.0	1.0	OK	259	1679	16	354
Map 2	C4690CYN-002	SN-2	7.0	11.5	OK	6748	2050	15	392
Map 2	C4690CYS-002	SS-2	7.2	3.0	OK	2863	2896	20	385
Map 2	C4680CYN-002	NS-2	8.0	1.0	OK	719	2862	12	296
Map 2	C4690CYN-003	SN-3	8.0	11.5	OK	3370	1405	15	513
Map 2	C4690CYS-003	SS-3	8.1	3.0	OK	1338	1523	13	292
Map 2	C4680CYN-003	NS-3	9.0	1.0	OK	309	1405	18	532
Map 2	C4690CYN-004	SN-4	9.0	11.5	OK	3493	2199	13	337
Map 2	C4690CYS-004	SS-4	9.1	3.0	OK	2022	2012	15	439
Map 2	C4680CYN-012	NS-12	10.0	0.0	OK	82	1115	11	269
Map 2	C4680CYN-004	NS-4	10.0	1.0	OK	350	1601	17	660
Map 2	C4690CYN-005	SN-5	10.0	11.5	OK	1070	449	11	664
Map 2	C4690CYS-005	SS-5	10.1	3.0	OK	184	433	7	365
Map 2	C4680CYN-005	NS-5	11.0	1.0	OK	49	638	16	1614
Map 2	C4690CYN-006	SN-6	11.0	11.5	OK	2322	392	11	329
Map 2	C4690CYS-006	SS-6	11.1	3.0	OK	76	142	4	381
Map 2	C4680CYN-014	NS-14	12.0	0.0	OK	9	402	9	277

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord		Concentration (ppm)			
						As	Pb	Cd	Zn
Map 2	C4680CYN-006	NS-6	12.0	1.0	OK	58	1185	14	369
Map 2	C4690CYB-091	B-91	12.0	3.0	OK	70	146	5	354
Map 2	C4690CYB-081	B-81	12.0	4.0	OK	289	337	4	373
Map 2	C4690CYB-011	B-11	12.0	11.0	OK	71	219	5	1533
Map 2	C4690CYB-001	B-1	12.0	12.0	OK	160	197	5	265
Map 2	C4694CYB-091	B-91	12.0	13.0	OK	9	144	4	497
Map 2	C4694CYB-071	B-71	12.0	15.0	OK	22	119	4	255
Map 2	C4680CYN-015	NS-15	13.0	0.0	OK	59	219	13	175
Map 2	C4680CYN-007	NS-7	13.0	1.0	OK	50	1165	13	246
Map 2	C4690CYB-092	B-92	13.0	3.0	OK	188	256	5	455
Map 2	C4690CYB-082	B-82	13.0	4.0	OK	785	1165	10	349
Map 2	C4690CYB-072	B-72	13.0	5.0	OK	1686	1415	17	373
Map 2	C4690CYB-062	B-62	13.0	6.0	OK	5667	2896	22	435
Map 2	C4690CYB-052	B-52	13.0	7.0	OK	3781	1454	9	614
Map 2	C4690CYB-042	B-42	13.0	8.0	OK	4904	2245	15	316
Map 2	C4690CYB-022	B-22	13.0	10.0	OK	54	182	4	256
Map 2	C4690CYB-012	B-12	13.0	11.0	OK	78	133	5	196
Map 2	C4690CYB-002	B-2	13.0	12.0	OK	74	161	5	245
Map 2	C4694CYB-092	B-92	13.0	13.0	OK	27	135	4	267
Map 2	C4694CYB-072	B-72	13.0	15.0	OK	9	167	7	309
Map 2	C4690CYB-093	B-93	14.0	3.0	OK	2759	1832	16	513
Map 2	C4690CYB-083	B-83	14.0	4.0	OK	2357	3269	23	447
Map 2	C4690CYB-073	B-73	14.0	5.0	OK	3375	2922	18	277
Map 2	C4690CYB-063	B-63	14.0	6.0	OK	5429	2382	22	392
Map 2	C4690CYB-053	B-53	14.0	7.0	OK	3488	1355	15	341
Map 2	C4690CYB-043	B-43	14.0	8.0	OK	1962	987	12	291
Map 2	C4690CYB-033	B-33	14.0	9.0	OK	49	65	2	155
Map 2	C4690CYB-023	B-23	14.0	10.0	OK	51	171	6	203
Map 2	C4690CYB-013	B-13	14.0	11.0	OK	28	149	6	208
Map 2	C4690CYB-003	B-3	14.0	12.0	OK	73	157	7	221
Map 2	C4680CYB-019	B-19	15.0	0.0	OK	58	343	9	326
Map 2	C4680CYB-010	B-10	15.0	1.0	OK	9	556	12	275
Map 2	C4690CYB-094	B-94	15.0	3.0	OK	988	1630	12	301
Map 2	C4690CYB-084	B-84	15.0	4.0	OK	1651	1717	15	317
Map 2	C4690CYB-074	B-74	15.0	5.0	OK	6139	2473	14	250
Map 2	C4690CYB-064	B-64	15.0	6.0	OK	11785	2152	19	316
Map 2	C4690CYB-054	B-54	15.0	7.0	OK	831	442	9	361
Map 2	C4690CYB-044	B-44	15.0	8.0	OK	1791	1074	14	245
Map 2	C4690CYB-034	B-34	15.0	9.0	OK	2027	553	10	255
Map 2	C4690CYB-024	B-24	15.0	10.0	OK	239	223	5	202
Map 2	C4690CYB-014	B-14	15.0	11.0	OK	21	148	5	204
Map 2	C4690CYB-004	B-4	15.0	12.0	OK	37	127	8	435
Map 2	C4694CYB-094	B-94	15.0	13.0	OK	9	170	8	420
Map 2	C4680CYB-020	B-20	16.0	0.0	OK	106	916	12	326
Map 2	C4680CYB-011	B-11	16.0	1.0	OK	133	693	9	255
Map 2	C4690CYB-095	B-95	16.0	3.0	OK	82	290	6	185
Map 2	C4690CYB-085	B-85	16.0	4.0	OK	1500	1236	14	245
Map 2	C4690CYB-075	B-75	16.0	5.0	OK	3046	3227	15	350
Map 2	C4690CYB-065	B-65	16.0	6.0	OK	1424	608	10	240
Map 2	C4690CYB-055	B-55	16.0	7.0	OK	6934	1688	24	361
Map 2	C4690CYB-045	B-45	16.0	8.0	OK	1641	799	11	207
Map 2	C4690CYB-035	B-35	16.0	9.0	OK	3576	1256	16	229
Map 2	C4690CYB-025	B-25	16.0	10.0	OK	85	212	5	211

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 2	C4690CYB-015	B-15	16.0	11.0	OK	29	161	6	198
Map 2	C4690CYB-005	B-5	16.0	12.0	OK	107	229	6	672
Map 2	C4694CYB-085	B-85	16.0	14.0	OK	9	52	2	88
Map 2	C4694CYB-075	B-75	16.0	15.0	OK	3046	3227	15	350
Map 2	C4680CYB-021	B-21	17.0	0.0	OK	239	696	10	285
Map 2	C4680CYB-012	B-12	17.0	1.0	OK	109	1196	9	338
Map 2	C4690CYB-096	B-96	17.0	3.0	OK	1004	1708	15	341
Map 2	C4690CYB-086	B-86	17.0	4.0	OK	525	927	10	408
Map 2	C4690CYB-076	B-76	17.0	5.0	OK	3444	2922	19	290
Map 2	C4690CYB-066	B-66	17.0	6.0	OK	2222	1620	14	309
Map 2	C4690CYB-056	B-56	17.0	7.0	OK	3728	1125	14	276
Map 2	C4690CYB-046	B-46	17.0	8.0	OK	1394	864	13	216
Map 2	C4690CYB-036	B-36	17.0	9.0	OK	2037	984	12	250
Map 2	C4690CYB-026	B-26	17.0	10.0	OK	80	177	5	234
Map 2	C4690CYB-016	B-16	17.0	11.0	OK	56	170	4	199
Map 2	C4690CYB-006	B-6	17.0	12.0	OK	31	197	5	439
Map 2	C4694CYB-086	B-86	17.0	14.0	OK	9	146	4	180
Map 2	C4694CYB-076	B-76	17.0	15.0	OK	39	119	6	119
Map 2	C4680CYB-022	B-22	18.0	0.0	OK	121	412	7	392
Map 2	C4680CYB-013	B-13	18.0	1.0	OK	175	797	9	458
Map 2	C4690CYB-097	B-97	18.0	3.0	OK	545	1135	13	228
Map 2	C4690CYB-087	B-87	18.0	4.0	OK	415	803	11	187
Map 2	C4690CYB-077	B-77	18.0	5.0	OK	1394	2346	14	266
Map 2	C4690CYB-067	B-67	18.0	6.0	OK	2027	1659	11	194
Map 2	C4690CYB-057	B-57	18.0	7.0	OK	2202	981	13	232
Map 2	C4690CYB-047	B-47	18.0	8.0	OK	1469	984	13	242
Map 2	C4690CYB-037	B-37	18.0	9.0	OK	371	446	6	263
Map 2	C4690CYB-027	B-27	18.0	10.0	OK	43	151	4	178
Map 2	C4690CYB-017	B-17	18.0	11.0	OK	74	162	5	191
Map 2	C4690CYB-007	B-7	18.0	12.0	OK	9	248	8	354
Map 2	C4694CYB-097	B-97	18.0	13.0	OK	9	105	4	761
Map 2	C4694CYB-087	B-87	18.0	14.0	OK	9	80	5	128
Map 2	C4694CYB-077	B-77	18.0	15.0	OK	9	148	2	98
Map 2	C4680CYB-023	B-23	19.0	0.0	OK	71	265	7	258
Map 2	C4680CYB-014	B-14	19.0	1.0	OK	148	965	12	244
Map 2	C4690CYB-098	B-98	19.0	3.0	OK	1151	3034	10	282
Map 2	C4690CYB-088	B-88	19.0	4.0	OK	647	1813	15	287
Map 2	C4690CYB-078	B-78	19.0	5.0	OK	1176	2957	12	301
Map 2	C4690CYB-068	B-68	19.0	6.0	OK	3055	2775	16	314
Map 2	C4690CYB-058	B-58	19.0	7.0	OK	958	1135	12	252
Map 2	C4690CYB-048	B-48	19.0	8.0	OK	995	1325	10	273
Map 2	C4690CYB-038	B-38	19.0	9.0	OK	3640	1503	16	455
Map 2	C4690CYB-028	B-28	19.0	10.0	OK	2262	2464	16	361
Map 2	C4690CYB-018	B-18	19.0	11.0	OK	74	184	6	219
Map 2	C4690CYB-008	B-8	19.0	12.0	OK	9	217	7	273
Map 2	C4694CYB-098	B-98	19.0	13.0	OK	9	212	6	1463
Map 2	C4694CYB-088	B-88	19.0	14.0	OK	9	109	5	145
Map 2	C4694CYB-078	B-78	19.0	15.0	OK	51	100	2	174
Map 2	C4680CYB-024	B-24	20.0	0.0	OK	79	492	10	282
Map 2	C4680CYB-015	B-15	20.0	1.0	OK	9	969	12	231
Map 2	C4690CYB-099	B-99	20.0	3.0	OK	28	179	5	466
Map 2	C4690CYB-089	B-89	20.0	4.0	OK	86	188	7	256
Map 2	C4690CYB-079	B-79	20.0	5.0	OK	581	717	14	243

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 2	C4690CYB-069	B-69	20.0	6.0	OK	6841	2853	22	385
Map 2	C4690CYB-059	B-59	20.0	7.0	OK	2292	1640	18	462
Map 2	C4690CYB-049	B-49	20.0	8.0	OK	1987	1365	14	551
Map 2	C4690CYB-039	B-39	20.0	9.0	OK	1615	1965	15	443
Map 2	C4690CYB-029	B-29	20.0	10.0	OK	494	294	8	296
Map 2	C4690CYB-019	B-19	20.0	11.0	OK	77	212	6	232
Map 2	C4694CYB-099	B-99	20.0	13.0	OK	19	96	5	365
Map 2	C4680CYB-025	B-25	21.0	0.0	OK	27	404	8	223
Map 2	C4680CYB-016	B-16	21.0	1.0	OK	60	605	15	350
Map 2	C4690CYB-100	B-100	21.0	3.0	OK	26	137	5	320
Map 2	C4690CYB-090	B-90	21.0	4.0	OK	9	176	8	262
Map 2	C4690CYB-040	B-40	21.0	9.0	OK	53	494	8	614
Map 2	C4690CYB-030	B-30	21.0	10.0	OK	1293	775	12	528
Map 2	C4690CYB-020	B-20	21.0	11.0	OK	94	236	4	302
Map 2	C4690CYB-010	B-10	21.0	12.0	OK	43	257	8	381
Map 2	C4694CYB-100	B-100	21.0	13.0	OK	23	135	6	920
Map 2	C4694CYB-090	B-90	21.0	14.0	OK	87	149	5	243
Map 2	C4680CYB-017	B-17	22.0	1.0	OK	66	324	9	212
Map 2	C4680CYB-027	B-27	23.0	0.0	OK	9	1206	15	2269
Map 2	C4680CYB-018	B-18	23.0	1.0	OK	9	317	10	602
Map 2	C4685FIB-106	B-106	35.0	5.0	OK	33	194	7	745
Map 2	C4685FIB-091	B-91	35.0	6.0	OK	9	177	8	862
Map 2	C4685FIB-076	B-76	35.0	7.0	OK	35	151	4	513
Map 2	C4685FIB-061	B-61	35.0	8.0	OK	24	85	5	207
Map 2	C4685FIB-046	B-46	35.0	9.0	OK	9	78	2	136
Map 2	C4685FIB-031	B-31	35.0	10.0	OK	20	62	2	130
Map 2	C4685FIB-001	B-1	35.0	12.0	OK	22	106	4	299
Map 2	C4685FIB-152	B-152	36.0	2.0	OK	9	211	5	582
Map 2	C4685FIB-047	B-47	36.0	9.0	OK	206	675	5	176
Map 2	C4685FIB-032	B-32	36.0	10.0	OK	28	68	5	112
Map 2	C4685FIB-002	B-2	36.0	12.0	OK	9	132	5	282
Map 2	C4685FIB-153	B-153	37.0	2.0	OK	43	175	5	478
Map 2	C4685FIB-063	B-63	37.0	8.0	OK	424	1572	6	216
Map 2	C4685FIB-048	B-48	37.0	9.0	OK	123	492	6	111
Map 2	C4685FIB-033	B-33	37.0	10.0	OK	658	1266	7	185
Map 2	C4685FIB-018	B-18	37.0	11.0	OK	9	72	2	138
Map 2	C4685FIB-003	B-3	37.0	12.0	OK	29	83	4	206
Map 2					OK	76	1145	15	520
Map 3	C4850ADF-101	F-101	0.0	0.0		19	140	4	229
Map 3	C4850ADF-091	F-91	0.0	1.0	OK	22	166	4	240
Map 3	C4850ADF-081	F-81	0.0	2.0	OK	9	178	5	289
Map 3	C4850ADF-071	F-71	0.0	3.0	OK	9	129	4	220
Map 3	C4850ADF-061	F-61	0.0	4.0	OK	9	152	4	340
Map 3	C4850ADF-051	F-51	0.0	5.0	OK	58	184	5	208
Map 3	C4850ADF-031	F-31	0.0	7.0	OK	9	54	2	63
Map 3	C4850ADF-021	F-21	0.0	8.0	OK	58	209	5	88
Map 3	C4850ADF-011	F-11	0.0	9.0	OK	69	274	6	163
Map 3	C4850ADF-001	F-1	0.0	10.0	OK	167	320	7	210
Map 3	C4850ADF-102	F-102	1.0	0.0	OK	2386	768	10	517
Map 3	C4850ADF-092	F-92	1.0	1.0	OK	856	461	10	202
Map 3	C4850ADF-082	F-82	1.0	2.0	OK	1054	409	9	308
Map 3	C4850ADF-072	F-72	1.0	3.0	OK	1343	419	11	194
Map 3	C4850ADF-062	F-62	1.0	4.0	OK	169	147	2	130

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 3	C4850ADF-052	F-52	1.0	5.0	OK	195	290	5	94
Map 3	C4850ADF-032	F-32	1.0	7.0	OK	9	39	2	56
Map 3	C4850ADF-022	F-22	1.0	8.0	OK	68	37	2	74
Map 3	C4850ADF-012	F-12	1.0	9.0	OK	31	54	2	128
Map 3	C4850ADF-002	F-2	1.0	10.0	OK	44	155	5	1203
Map 3	C4850ADF-103	F-103	2.0	0.0	OK	304	259	8	172
Map 3	C4850ADF-093	F-93	2.0	1.0	OK	321	319	12	177
Map 3	C4850ADF-083	F-83	2.0	2.0	OK	607	457	10	203
Map 3	C4850ADF-073	F-73	2.0	3.0	OK	709	428	8	186
Map 3	C4850ADF-063	F-63	2.0	4.0	OK	693	435	11	188
Map 3	C4850ADF-053	F-53	2.0	5.0	OK	238	277	5	135
Map 3	C4850ADF-033	F-33	2.0	7.0	OK	76	26	5	61
Map 3	C4850ADF-023	F-23	2.0	8.0	OK	45	58	2	78
Map 3	C4850ADF-013	F-13	2.0	9.0	OK	111	241	5	159
Map 3	C4850ADF-003	F-3	2.0	10.0	OK	54	153	4	344
Map 3	C4850ADF-104	F-104	3.0	0.0	OK	365	316	7	165
Map 3	C4850ADF-094	F-94	3.0	1.0	OK	404	372	11	179
Map 3	C4850ADF-084	F-84	3.0	2.0	OK	55	137	4	146
Map 3	C4850ADF-074	F-74	3.0	3.0	OK	586	340	10	222
Map 3	C4850ADF-064	F-64	3.0	4.0	OK	119	160	2	97
Map 3	C4850ADF-054	F-54	3.0	5.0	OK	109	180	9	156
Map 3	C4850ADF-044	F-44	3.0	6.0	OK	581	437	12	263
Map 3	C4850ADF-034	F-34	3.0	7.0	OK	62	31	4	70
Map 3	C4850ADF-024	F-24	3.0	8.0	OK	9	22	2	58
Map 3	C4850ADF-014	F-14	3.0	9.0	OK	658	663	9	211
Map 3	C4850ADF-004	F-4	3.0	10.0	OK	107	216	7	358
Map 3	C4850ADF-105	F-105	4.0	0.0	OK	360	222	8	121
Map 3	C4850ADF-095	F-95	4.0	1.0	OK	237	148	4	108
Map 3	C4850ADF-085	F-85	4.0	2.0	OK	988	579	5	218
Map 3	C4850ADF-075	F-75	4.0	3.0	OK	1070	640	10	238
Map 3	C4850ADF-065	F-65	4.0	4.0	OK	668	522	7	163
Map 3	C4850ADF-055	F-55	4.0	5.0	OK	1171	596	11	196
Map 3	C4850ADF-045	F-45	4.0	6.0	OK	1044	594	15	239
Map 3	C4850ADF-035	F-35	4.0	7.0	OK	27	40	2	100
Map 3	C4850ADF-025	F-25	4.0	8.0	OK	31	33	4	77
Map 3	C4850ADF-015	F-15	4.0	9.0	OK	383	580	9	264
Map 3	C4850ADF-005	F-5	4.0	10.0	OK	127	302	9	474
Map 3	C4850ADF-106	F-106	5.0	0.0	OK	335	167	10	121
Map 3	C4850ADF-096	F-96	5.0	1.0	OK	353	201	7	131
Map 3	C4850ADF-086	F-86	5.0	2.0	OK	424	199	10	128
Map 3	C4850ADF-076	F-76	5.0	3.0	OK	494	288	4	142
Map 3	C4850ADF-066	F-66	5.0	4.0	OK	52	96	2	71
Map 3	C4850ADF-056	F-56	5.0	5.0	OK	1181	705	17	326
Map 3	C4850ADF-046	F-46	5.0	6.0	OK	795	527	14	286
Map 3	C4850ADF-036	F-36	5.0	7.0	OK	43	48	2	90
Map 3	C4850ADF-026	F-26	5.0	8.0	OK	44	65	2	106
Map 3	C4850ADF-016	F-16	5.0	9.0	OK	2367	1542	17	365
Map 3	C4850ADF-006	F-6	5.0	10.0	OK	197	249	7	400
Map 3	C4850ADF-107	F-107	6.0	0.0	OK	734	639	12	268
Map 3	C4850ADF-097	F-97	6.0	1.0	OK	607	766	8	221
Map 3	C4850ADF-087	F-87	6.0	2.0	OK	305	191	9	119
Map 3	C4850ADF-077	F-77	6.0	3.0	OK	933	684	12	247
Map 3	C4850ADF-067	F-67	6.0	4.0	OK	2729	1425	22	404

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 3	C4850ADF-057	F-57	6.0	5.0	OK	988	767	5	156
Map 3	C4850ADF-047	F-47	6.0	6.0	OK	775	507	10	302
Map 3	C4850ADF-037	F-37	6.0	7.0	OK	72	73	4	117
Map 3	C4850ADF-027	F-27	6.0	8.0	OK	66	84	2	99
Map 3	C4850ADF-017	F-17	6.0	9.0	OK	653	473	6	257
Map 3	C4850ADF-007	F-7	6.0	10.0	OK	226	231	6	423
Map 3	C4850ADF-108	F-108	7.0	0.0	OK	749	664	18	334
Map 3	C4850ADF-098	F-98	7.0	1.0	OK	530	447	10	198
Map 3	C4850ADF-088	F-88	7.0	2.0	OK	483	364	10	195
Map 3	C4850ADF-078	F-78	7.0	3.0	OK	450	376	10	225
Map 3	C4850ADF-068	F-68	7.0	4.0	OK	739	457	9	196
Map 3	C4850ADF-058	F-58	7.0	5.0	OK	714	440	12	256
Map 3	C4850ADF-048	F-48	7.0	6.0	OK	422	294	10	225
Map 3	C4850ADF-038	F-38	7.0	7.0	OK	74	92	2	128
Map 3	C4850ADF-028	F-28	7.0	8.0	OK	34	51	4	120
Map 3	C4850ADF-018	F-18	7.0	9.0	OK	887	684	9	267
Map 3	C4850ADF-008	F-8	7.0	10.0	OK	182	266	7	517
Map 3	C4850ADF-109	F-109	8.0	0.0	OK	658	611	12	420
Map 3	C4850ADF-099	F-99	8.0	1.0	OK	369	308	12	206
Map 3	C4850ADF-089	F-89	8.0	2.0	OK	304	188	6	185
Map 3	C4850ADF-079	F-79	8.0	3.0	OK	339	204	6	153
Map 3	C4850ADF-069	F-69	8.0	4.0	OK	540	313	10	225
Map 3	C4850ADF-059	F-59	8.0	5.0	OK	138	148	5	158
Map 3	C4850ADF-049	F-49	8.0	6.0	OK	401	359	10	288
Map 3	C4850ADF-039	F-39	8.0	7.0	OK	127	171	6	183
Map 3	C4850ADF-029	F-29	8.0	8.0	OK	139	314	5	208
Map 3	C4850ADF-019	F-19	8.0	9.0	OK	653	642	11	301
Map 3	C4850ADF-009	F-9	8.0	10.0	OK	58	109	6	369
Map 3	C4850ADF-110	F-110	9.0	0.0	OK	617	338	9	279
Map 3	C4850ADF-100	F-100	9.0	1.0	OK	749	622	9	328
Map 3	C4850ADF-090	F-90	9.0	2.0	OK	912	612	8	206
Map 3	C4850ADF-080	F-80	9.0	3.0	OK	291	302	8	237
Map 3	C4850ADF-070	F-70	9.0	4.0	OK	183	220	10	210
Map 3	C4850ADF-060	F-60	9.0	5.0	OK	147	206	7	247
Map 3	C4850ADF-020	F-20	9.0	9.0	OK	142	181	8	493
Map 3	C4850ADF-010	F-10	9.0	10.0	OK	83	127	7	354
Map 3	C4850ADS-001	SS-1	10.0	1.0	OK	444	386	9	237
Map 3	C4850ADN-001	SN-1	10.0	9.0	OK	9	106	4	361
Map 3	C4850ADS-002	SS-2	11.0	1.0	OK	958	895	11	385
Map 3	C4850ADN-002	SN-2	11.0	9.0	OK	58	174	6	365
Map 3	C4850ADS-003	SS-3	12.0	1.0	OK	416	428	11	389
Map 3	C4850ADN-003	SN-3	12.0	9.0	OK	75	142	5	292
Map 3	C4850ADS-004	SS-4	13.0	1.0	OK	281	383	5	251
Map 3	C4850ADN-004	SN-4	13.0	9.0	OK	25	121	7	277
Map 3	C4850ADS-005	SS-5	14.0	1.0	OK	65	186	5	221
Map 3	C4850ADN-005	SN-5	14.0	9.0	OK	65	120	7	280
Map 3	C4850ADB-131	B-131	15.0	0.0	OK	52	218	7	524
Map 3	C4850ADB-118	B-118	15.0	1.0	OK	82	255	5	478
Map 3	C4850ADB-105	B-105	15.0	2.0	OK	57	172	2	249
Map 3	C4850ADB-092	B-92	15.0	3.0	OK	99	193	5	214
Map 3	C4850ADB-079	B-79	15.0	4.0	OK	165	297	5	354
Map 3	C4850ADB-066	B-66	15.0	5.0	OK	74	78	4	239
Map 3	C4850ADB-001	B-1	15.0	10.0	OK	87	100	4	354

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 3	C4850ADB-132	B-132	16.0	0.0	OK	673	311	9	309
Map 3	C4850ADB-119	B-119	16.0	1.0	OK	414	361	4	169
Map 3	C4850ADB-106	B-106	16.0	2.0	OK	617	254	7	150
Map 3	C4850ADB-093	B-93	16.0	3.0	OK	474	256	5	119
Map 3	C4850ADB-080	B-80	16.0	4.0	OK	249	251	2	224
Map 3	C4850ADB-041	B-41	16.0	7.0	OK	9	246	4	173
Map 3	C4850ADB-002	B-2	16.0	10.0	OK	44	88	2	322
Map 3	C4850ADB-133	B-133	17.0	0.0	OK	504	472	10	331
Map 3	C4850ADB-120	B-120	17.0	1.0	OK	244	201	5	123
Map 3	C4850ADB-107	B-107	17.0	2.0	OK	306	214	6	142
Map 3	C4850ADB-094	B-94	17.0	3.0	OK	800	376	6	153
Map 3	C4850ADB-081	B-81	17.0	4.0	OK	293	229	5	156
Map 3	C4850ADB-134	B-134	18.0	0.0	OK	235	463	5	237
Map 3	C4850ADB-095	B-95	18.0	3.0	OK	229	158	2	93
Map 3	C4850ADB-082	B-82	18.0	4.0	OK	673	406	8	178
Map 3	C4850ADB-069	B-69	18.0	5.0	OK	1080	492	8	165
Map 3	C4850ADB-056	B-56	18.0	6.0	OK	607	410	5	185
Map 3	C4850ADB-043	B-43	18.0	7.0	OK	239	275	6	182
Map 3	C4850ADB-030	B-30	18.0	8.0	OK	226	281	6	193
Map 3	C4850ADB-017	B-17	18.0	9.0	OK	315	285	8	482
Map 3	C4850ADB-004	B-4	18.0	10.0	OK	85	90	7	280
Map 3	C4850ADB-135	B-135	19.0	0.0	OK	239	405	6	294
Map 3	C4850ADB-122	B-122	19.0	1.0	OK	266	164	6	121
Map 3	C4850ADB-109	B-109	19.0	2.0	OK	226	166	5	180
Map 3	C4850ADB-096	B-96	19.0	3.0	OK	586	261	6	135
Map 3	C4850ADB-083	B-83	19.0	4.0	OK	1242	527	10	179
Map 3	C4850ADB-070	B-70	19.0	5.0	OK	472	286	7	158
Map 3	C4850ADB-057	B-57	19.0	6.0	OK	282	220	5	129
Map 3	C4850ADB-031	B-31	19.0	8.0	OK	419	382	7	203
Map 3	C4850ADB-018	B-18	19.0	9.0	OK	251	272	10	204
Map 3	C4850ADB-005	B-5	19.0	10.0	OK	30	92	5	582
Map 3	C4850ADB-136	B-136	20.0	0.0	OK	171	280	6	350
Map 3	C4850ADB-123	B-123	20.0	1.0	OK	180	111	6	120
Map 3	C4850ADB-110	B-110	20.0	2.0	OK	169	109	6	128
Map 3	C4850ADB-097	B-97	20.0	3.0	OK	163	153	7	104
Map 3	C4850ADB-084	B-84	20.0	4.0	OK	683	354	5	107
Map 3	C4850ADB-071	B-71	20.0	5.0	OK	400	271	8	123
Map 3	C4850ADB-058	B-58	20.0	6.0	OK	449	385	7	143
Map 3	C4850ADB-032	B-32	20.0	8.0	OK	463	611	7	178
Map 3	C4850ADB-019	B-19	20.0	9.0	OK	435	431	10	277
Map 3	C4850ADB-006	B-6	20.0	10.0	OK	75	94	5	288
Map 3	C4850ADB-137	B-137	21.0	0.0	OK	93	136	4	314
Map 3	C4850ADB-124	B-124	21.0	1.0	OK	191	148	6	119
Map 3	C4850ADB-111	B-111	21.0	2.0	OK	91	122	4	247
Map 3	C4850ADB-098	B-98	21.0	3.0	OK	136	241	4	131
Map 3	C4850ADB-085	B-85	21.0	4.0	OK	673	351	6	140
Map 3	C4850ADB-072	B-72	21.0	5.0	OK	887	399	6	106
Map 3	C4850ADB-059	B-59	21.0	6.0	OK	465	263	8	150
Map 3	C4850ADB-033	B-33	21.0	8.0	OK	390	429	9	150
Map 3	C4850ADB-020	B-20	21.0	9.0	OK	257	313	7	200
Map 3	C4850ADB-007	B-7	21.0	10.0	OK	9	80	5	277
Map 3	C4850ADB-138	B-138	22.0	0.0	OK	146	157	5	228
Map 3	C4850ADB-125	B-125	22.0	1.0	OK	451	198	7	137

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 3	C4850ADB-112	B-112	22.0	2.0	OK	105	198	2	158
Map 3	C4850ADB-099	B-99	22.0	3.0	OK	295	245	5	123
Map 3	C4850ADB-086	B-86	22.0	4.0	OK	1550	568	8	140
Map 3	C4850ADB-073	B-73	22.0	5.0	OK	1095	467	9	171
Map 3	C4850ADB-060	B-60	22.0	6.0	OK	437	290	8	135
Map 3	C4850ADB-034	B-34	22.0	8.0	OK	253	188	6	144
Map 3	C4850ADB-021	B-21	22.0	9.0	OK	405	303	7	222
Map 3	C4850ADB-008	B-8	22.0	10.0	OK	29	85	2	330
Map 3	C4850ADB-139	B-139	23.0	0.0	OK	96	171	6	344
Map 3	C4850ADB-126	B-126	23.0	1.0	OK	214	123	2	125
Map 3	C4850ADB-113	B-113	23.0	2.0	OK	217	142	2	176
Map 3	C4850ADB-100	B-100	23.0	3.0	OK	540	363	6	133
Map 3	C4850ADB-087	B-87	23.0	4.0	OK	607	287	5	120
Map 3	C4850ADB-074	B-74	23.0	5.0	OK	780	376	5	120
Map 3	C4850ADB-061	B-61	23.0	6.0	OK	441	325	6	120
Map 3	C4850ADB-035	B-35	23.0	8.0	OK	556	381	7	183
Map 3	C4850ADB-022	B-22	23.0	9.0	OK	1060	883	14	412
Map 3	C4850ADB-009	B-9	23.0	10.0	OK	41	100	2	340
Map 3	C4850ADB-101	B-101	24.0	3.0	OK	244	269	2	107
Map 3	C4850ADB-088	B-88	24.0	4.0	OK	556	263	4	141
Map 3	C4850ADB-075	B-75	24.0	5.0	OK	484	299	5	125
Map 3	C4850ADB-062	B-62	24.0	6.0	OK	1120	601	7	144
Map 3	C4850ADB-036	B-36	24.0	8.0	OK	637	454	8	212
Map 3	C4850ADB-023	B-23	24.0	9.0	OK	688	608	5	234
Map 3	C4850ADB-010	B-10	24.0	10.0	OK	59	80	6	381
Map 3	C4850ADB-141	B-141	25.0	0.0	OK	55	171	5	497
Map 3	C4850ADB-115	B-115	25.0	2.0	OK	183	184	6	223
Map 3	C4850ADB-102	B-102	25.0	3.0	OK	309	162	5	98
Map 3	C4850ADB-089	B-89	25.0	4.0	OK	432	286	7	116
Map 3	C4850ADB-076	B-76	25.0	5.0	OK	330	193	2	98
Map 3	C4850ADB-063	B-63	25.0	6.0	OK	324	188	6	97
Map 3	C4850ADB-037	B-37	25.0	8.0	OK	363	300	2	119
Map 3	C4850ADB-024	B-24	25.0	9.0	OK	73	89	2	95
Map 3	C4850ADB-011	B-11	25.0	10.0	OK	78	103	6	218
Map 3	C4850ADB-142	B-142	26.0	0.0	OK	49	134	6	385
Map 3	C4850ADB-116	B-116	26.0	2.0	OK	176	149	5	251
Map 3	C4850ADB-103	B-103	26.0	3.0	OK	1100	875	9	262
Map 3	C4850ADB-090	B-90	26.0	4.0	OK	1125	592	6	110
Map 3	C4850ADB-077	B-77	26.0	5.0	OK	375	206	2	110
Map 3	C4850ADB-064	B-64	26.0	6.0	OK	487	262	7	126
Map 3	C4850ADB-038	B-38	26.0	8.0	OK	202	213	7	263
Map 3	C4850ADB-025	B-25	26.0	9.0	OK	53	62	5	156
Map 3	C4850ADB-012	B-12	26.0	10.0	OK	31	58	2	220
Map 3	C4850ADB-143	B-143	27.0	0.0	OK	55	84	2	229
Map 3	C4850ADB-130	B-130	27.0	1.0	OK	119	201	5	404
Map 3	C4850ADB-117	B-117	27.0	2.0	OK	33	164	6	290
Map 3	C4850ADB-104	B-104	27.0	3.0	OK	57	166	4	396
Map 3	C4850ADB-091	B-91	27.0	4.0	OK	73	122	5	311
Map 3	C4850ADB-078	B-78	27.0	5.0	OK	35	126	2	377
Map 3	C4850ADB-065	B-65	27.0	6.0	OK	56	83	5	160
Map 4	C4771VIBA-004	A-4	0.0	1.0	OK	9	1937	11	1455
Map 4	C4771VIBA-003	A-3	0.0	2.0	OK	20	1581	7	1327
Map 4	C4771VIBA-002	A-2	0.0	3.0	OK	9	602	5	738

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 4	C4771VIB-016	B-16	3.0	5.0	OK	1328	1030	15	528
Map 4	C4771VIB-011	B-11	3.0	6.0	OK	254	433	12	431
Map 4	C4771VIB-006	B-6	3.0	7.0	OK	9	345	7	486
Map 4	C4771VIB-001	B-1	3.0	8.0	OK	73	299	6	392
Map 4	C4771VIB-017	B-17	4.0	5.0	OK	115	393	7	478
Map 4	C4771VIB-012	B-12	4.0	6.0	OK	2272	1889	15	567
Map 4	C4771VIB-007	B-7	4.0	7.0	OK	1095	1425	14	606
Map 4	C4771VIB-018	B-18	5.0	5.0	OK	1252	1784	22	652
Map 4	C4771VIB-013	B-13	5.0	6.0	OK	1222	1756	15	520
Map 4	C4771VIB-008	B-8	5.0	7.0	OK	933	1601	19	420
Map 4	C4771VIB-034	B-34	6.0	2.0	OK	107	619	11	381
Map 4	C4771VIB-029	B-29	6.0	3.0	OK	596	1010	13	792
Map 4	C4771VIB-024	B-24	6.0	4.0	OK	632	1659	23	939
Map 4	C4771VIB-019	B-19	6.0	5.0	OK	719	1175	14	341
Map 4	C4771VIB-014	B-14	6.0	6.0	OK	93	263	5	166
Map 4	C4771VIB-009	B-9	6.0	7.0	OK	928	1216	9	377
Map 4	C4771VIB-004	B-4	6.0	8.0	OK	9	474	7	392
Map 4	C4771VIB-040	B-40	7.0	1.0	OK	28	371	5	330
Map 4	C4771VIB-035	B-35	7.0	2.0	OK	171	692	9	392
Map 4	C4771VIB-030	B-30	7.0	3.0	OK	805	1765	16	582
Map 4	C4771VIB-025	B-25	7.0	4.0	OK	647	1355	20	575
Map 4	C4771VIB-020	B-20	7.0	5.0	OK	320	592	8	435
Map 4	C4771VIB-015	B-15	7.0	6.0	OK	25	1434	9	1218
Map 4	C4771VIB-010	B-10	7.0	7.0	OK	233	807	8	439
Map 4	C4771VIB-005	B-5	7.0	8.0	OK	52	257	6	1110
Map 4	C4771VIS-001	SS-1	8.0	1.0	OK	70	565	9	358
Map 4	C4771VIN-001	NS-1	8.0	8.0	OK	214	406	5	247
Map 4	C4771VIS-002	SS-2	9.0	1.0	OK	133	575	9	439
Map 4	C4771VIN-002	NS-2	9.0	8.0	OK	255	661	10	474
Map 4	C4771VIS-003	SS-3	10.0	1.0	OK	116	603	8	373
Map 4	C4771VIN-003	NS-3	10.0	8.0	OK	18	292	6	462
Map 4	C4771VIS-004	SS-4	11.0	1.0	OK	64	838	8	536
Map 4	C4771VIN-004	NS-4	11.0	8.0	OK	9	880	9	551
Map 4	C4771VIS-005	SS-5	12.0	1.0	OK	744	946	14	416
Map 4	C4771VIN-005	NS-5	12.0	8.0	OK	114	784	10	625
Map 4	C4771VIS-006	SS-6	13.0	1.0	OK	1282	1375	39	1242
Map 4	C4771VIN-006	NS-6	13.0	8.0	OK	31	1155	13	1032
Map 4	C4771VIS-007	SS-7	14.0	1.0	OK	1962	2731	28	726
Map 4	C4771VIN-007	NS-7	14.0	8.0	OK	50	422	6	427
Map 4	C4771VIS-008	SS-8	15.0	1.0	OK	1186	1688	29	1195
Map 4	C4771VIN-008	NS-8	15.0	8.0	OK	9	565	12	846
Map 4	C4771VIS-009	SS-9	16.0	1.0	OK	2536	1813	23	598
Map 4	C4771VIN-009	NS-9	16.0	8.0	OK	9	1145	13	1164
Map 4	C4771VIS-010	SS-10	17.0	1.0	OK	713	931	16	474
Map 4	C4771VIN-010	NS-10	17.0	8.0	OK	46	649	12	772
Map 4	C4771VIS-011	SS-11	18.0	1.0	OK	1039	1145	11	420
Map 4	C4771VIS-012	SS-12	19.0	1.0	OK	658	933	14	389
Map 4	C4771VIF-049	F-49	20.0	0.0	OK	9	419	14	920
Map 4	C4771VIF-043	F-43	20.0	1.0	OK	1110	1395	15	470
Map 4	C4771VIF-025	F-25	20.0	4.0	OK	36	490	15	563
Map 4	C4771VIF-013	F-13	20.0	6.0	OK	9	750	13	617
Map 4	C4771VIF-007	F-7	20.0	7.0	OK	800	1640	20	579
Map 4	C4771VIF-001	F-1	20.0	8.0	OK	9	257	6	831

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 4	C4771VIF-044	F-44	21.0	1.0	OK	1014	2263	14	462
Map 4	C4771VIF-038	F-38	21.0	2.0	OK	437	1870	22	652
Map 4	C4771VIF-032	F-32	21.0	3.0	OK	72	539	12	431
Map 4	C4771VIF-026	F-26	21.0	4.0	OK	443	1784	18	482
Map 4	C4771VIF-014	F-14	21.0	6.0	OK	1469	2254	16	645
Map 4	C4771VIF-008	F-8	21.0	7.0	OK	647	1484	17	517
Map 4	C4771VIF-002	F-2	21.0	8.0	OK	35	308	5	505
Map 4	C4771VIF-051	F-51	22.0	0.0	OK	223	627	26	1308
Map 4	C4771VIF-045	F-45	22.0	1.0	OK	1338	1611	17	328
Map 4	C4771VIF-039	F-39	22.0	2.0	OK	688	1908	17	404
Map 4	C4771VIF-033	F-33	22.0	3.0	OK	821	1889	18	427
Map 4	C4771VIF-027	F-27	22.0	4.0	OK	912	2171	12	389
Map 4	C4771VIF-015	F-15	22.0	6.0	OK	1530	2757	25	482
Map 4	C4771VIF-009	F-9	22.0	7.0	OK	1262	3127	18	447
Map 4	C4771VIF-003	F-3	22.0	8.0	OK	9	347	8	629
Map 4	C4771VIF-052	F-52	23.0	0.0	OK	9	106	2	306
Map 4	C4771VIF-046	F-46	23.0	1.0	OK	9	414	5	443
Map 4	C4771VIF-040	F-40	23.0	2.0	OK	9	505	8	517
Map 4	C4771VIF-034	F-34	23.0	3.0	OK	9	341	7	536
Map 4	C4771VIF-016	F-16	23.0	6.0	OK	9	433	11	486
Map 4	C4771VIF-010	F-10	23.0	7.0	OK	40	388	9	520
Map 4	C4771VIF-004	F-4	23.0	8.0	OK	9	355	9	555
Map 4	C4771VIF-047	F-47	24.0	1.0	OK	902	1145	14	392
Map 4	C4771VIF-035	F-35	24.0	3.0	OK	434	718	12	327
Map 4	C4771VIF-054	F-54	25.0	0.0	OK	1700	1842	22	462
Map 4	C4771VIF-048	F-48	25.0	1.0	OK	111	531	16	1063
Map 4	C4771VIF-042	F-42	25.0	2.0	OK	688	1054	11	493
Map 4	C4771VIF-030	F-30	25.0	4.0	OK	499	917	14	349
Map 4	C4771VIF-024	F-24	25.0	5.0	OK	37	93	4	63
Map 4	C4771VIF-018	F-18	25.0	6.0	OK	386	755	15	369
Map 4	C4771VIF-012	F-12	25.0	7.0	OK	525	1444	17	439
Map 4	C4771VIF-006	F-6	25.0	8.0	OK	1277	1804	24	470
Map 4					OK	775	901	12	389
Map 5	C200047B-138	B-138	0.0	1.4	OK	199	681	12	338
Map 5	C200047B-128	B-128	0.0	3.0	OK	1897	1493	18	427
Map 5	C200047B-118	B-118	0.0	4.0	OK	688	736	14	381
Map 5	C200047B-108	B-108	0.0	5.0	OK	75	428	7	354
Map 5	C200047B-098	B-98	0.0	6.0	OK	617	651	14	341
Map 5	C200047B-088	B-88	0.0	7.0	OK	351	437	7	381
Map 5	C200047B-078	B-78	0.0	8.0	OK	9	262	7	354
Map 5	C200047B-068	B-68	0.0	9.0	OK	303	542	8	427
Map 5	C200047B-058	B-58	0.0	10.0	OK	390	471	7	427
Map 5	C200047B-048	B-48	0.0	11.0	OK	213	497	10	458
Map 5	C200047B-038	B-38	0.0	12.0	OK	233	568	11	555
Map 5	C200047B-028	B-28	0.0	13.0	OK	138	326	7	517
Map 5	C200047B-008	B-8	0.0	15.0	OK	53	176	5	226
Map 5	C200047B-139	B-139	1.0	1.4	OK	137	391	7	334
Map 5	C200047B-129	B-129	1.0	3.0	OK	255	547	8	439
Map 5	C200047B-119	B-119	1.0	4.0	OK	2685	1053	16	400
Map 5	C200047B-109	B-109	1.0	5.0	OK	2660	1355	16	329
Map 5	C200047B-099	B-99	1.0	6.0	OK	324	594	12	427
Map 5	C200047B-089	B-89	1.0	7.0	OK	321	702	12	373
Map 5	C200047B-079	B-79	1.0	8.0	OK	190	650	12	377

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 5	C200047B-069	B-69	1.0	9.0	OK	493	596	11	447
Map 5	C200047B-059	B-59	1.0	10.0	OK	293	478	8	443
Map 5	C200047B-049	B-49	1.0	11.0	OK	94	454	9	462
Map 5	C200047B-039	B-39	1.0	12.0	OK	205	470	9	427
Map 5	C200047B-029	B-29	1.0	13.0	OK	102	242	8	486
Map 5	C200047B-009	B-9	1.0	15.0	OK	105	232	2	344
Map 5	C200047B-140	B-140	2.0	1.4	OK	83	422	6	377
Map 5	C200047B-120	B-120	2.0	4.0	OK	140	743	7	528
Map 5	C200047B-110	B-110	2.0	5.0	OK	1338	818	13	637
Map 5	C200047B-100	B-100	2.0	6.0	OK	2127	812	15	451
Map 5	C200047B-090	B-90	2.0	7.0	OK	410	829	10	451
Map 5	C200047B-080	B-80	2.0	8.0	OK	1257	783	12	361
Map 5	C200047B-070	B-70	2.0	9.0	OK	341	578	12	458
Map 5	C200047B-060	B-60	2.0	10.0	OK	346	631	9	524
Map 5	C200047B-050	B-50	2.0	11.0	OK	181	505	10	505
Map 5	C200047B-040	B-40	2.0	12.0	OK	215	512	9	517
Map 5	C200047B-030	B-30	2.0	13.0	OK	127	233	2	317
Map 5	C200047B-010	B-10	2.0	15.0	OK	103	144	2	193
Map 5	C4691VIB-085	B-85	10.0	3.0	OK	3041	1513	19	1172
Map 5	C4691VIB-057	B-57	10.0	7.0	OK	315	1135	10	885
Map 5	C4691VIB-050	B-50	10.0	8.0	OK	75	505	7	741
Map 5	C4691VIB-043	B-43	10.0	9.0	OK	121	532	9	699
Map 5	C4691VIB-036	B-36	10.0	10.0	OK	70	796	11	959
Map 5	C4691VIB-029	B-29	10.0	11.0	OK	143	587	9	629
Map 5	C4691VIB-022	B-22	10.0	12.0	OK	892	1040	10	3526
Map 5	C4691VIB-015	B-15	10.0	13.0	OK	3552	4210	28	517
Map 5	C4691VIB-001	B-1	10.0	15.0	OK	165	168	2	236
Map 5	C4691VIB-086	B-86	11.0	3.0	OK	5429	2775	22	1540
Map 5	C4691VIB-072	B-72	11.0	5.0	OK	2456	4143	23	738
Map 5	C4691VIB-065	B-65	11.0	6.0	OK	2476	2171	18	672
Map 5	C4691VIB-058	B-58	11.0	7.0	OK	410	909	9	470
Map 5	C4691VIB-051	B-51	11.0	8.0	OK	1277	2087	17	455
Map 5	C4691VIB-044	B-44	11.0	9.0	OK	1686	1727	14	431
Map 5	C4691VIB-037	B-37	11.0	10.0	OK	4103	2482	13	439
Map 5	C4691VIB-030	B-30	11.0	11.0	OK	2838	2695	17	590
Map 5	C4691VIB-023	B-23	11.0	12.0	OK	363	556	11	598
Map 5	C4691VIB-016	B-16	11.0	13.0	OK	1510	1775	19	707
Map 5	C4691VIB-002	B-2	11.0	15.0	OK	398	954	8	474
Map 5	C4683VIB-011	B-11	12.0	0.0	OK	56	49	2	131
Map 5	C4683VIB-006	B-6	12.0	1.0	OK	29	163	6	247
Map 5	C4683VIB-001	B-1	12.0	2.0	OK	54	410	2	1001
Map 5	C4691VIB-087	B-87	12.0	3.0	OK	2272	2106	22	586
Map 5	C4691VIB-073	B-73	12.0	5.0	OK	887	1286	12	478
Map 5	C4691VIB-066	B-66	12.0	6.0	OK	1651	2282	20	590
Map 5	C4691VIB-059	B-59	12.0	7.0	OK	1701	2254	20	563
Map 5	C4691VIB-052	B-52	12.0	8.0	OK	576	1325	15	474
Map 5	C4691VIB-045	B-45	12.0	9.0	OK	902	1306	17	846
Map 5	C4691VIB-031	B-31	12.0	11.0	OK	2769	1832	15	621
Map 5	C4691VIB-024	B-24	12.0	12.0	OK	968	1493	16	718
Map 5	C4691VIB-017	B-17	12.0	13.0	OK	1378	1395	15	931
Map 5	C4691VIB-003	B-3	12.0	15.0	OK	121	150	2	228
Map 5	C4683VIB-002	B-2	13.0	2.0	OK	65	411	6	1001
Map 5	C4691VIB-088	B-88	13.0	3.0	OK	963	1316	21	648

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 5	C4691VIB-074	B-74	13.0	5.0	OK	2122	2687	25	602
Map 5	C4691VIB-067	B-67	13.0	6.0	OK	760	1405	10	885
Map 5	C4691VIB-060	B-60	13.0	7.0	OK	1917	2236	16	540
Map 5	C4691VIB-053	B-53	13.0	8.0	OK	846	1165	17	858
Map 5	C4691VIB-046	B-46	13.0	9.0	OK	1676	1659	18	858
Map 5	C4691VIB-039	B-39	13.0	10.0	OK	7165	4008	25	486
Map 5	C4691VIB-025	B-25	13.0	12.0	OK	3223	2464	17	668
Map 5	C4691VIB-018	B-18	13.0	13.0	OK	3498	1775	18	741
Map 5	C4691VIB-004	B-4	13.0	15.0	OK	44	131	2	239
Map 5	C4683VIB-013	B-13	14.0	0.0	OK	38	15	2	80
Map 5	C4683VIB-008	B-8	14.0	1.0	OK	9	87	2	149
Map 5	C4691VIB-082	B-82	14.0	4.0	OK	13171	2982	17	796
Map 5	C4691VIB-075	B-75	14.0	5.0	OK	3041	3635	19	745
Map 5	C4691VIB-068	B-68	14.0	6.0	OK	922	1669	13	447
Map 5	C4691VIB-061	B-61	14.0	7.0	OK	2122	2069	22	482
Map 5	C4691VIB-054	B-54	14.0	8.0	OK	3095	2535	20	517
Map 5	C4691VIB-047	B-47	14.0	9.0	OK	3006	2003	26	458
Map 5	C4691VIB-033	B-33	14.0	11.0	OK	2878	2598	14	482
Map 5	C4691VIB-026	B-26	14.0	12.0	OK	3228	2544	19	745
Map 5	C4691VIB-019	B-19	14.0	13.0	OK	2391	1870	21	788
Map 5	C4691VIB-005	B-5	14.0	15.0	OK	74	161	5	255
Map 5	C4683VIB-009	B-9	15.0	1.0	OK	20	101	2	216
Map 5	C4691VIB-090	B-90	15.0	3.0	OK	2461	1155	15	660
Map 5	C4691VIB-083	B-83	15.0	4.0	OK	96	629	7	997
Map 5	C4691VIB-076	B-76	15.0	5.0	OK	780	930	11	738
Map 5	C4691VIB-069	B-69	15.0	6.0	OK	2097	3194	23	606
Map 5	C4691VIB-055	B-55	15.0	8.0	OK	2570	1851	17	536
Map 5	C4691VIB-048	B-48	15.0	9.0	OK	5239	2364	18	497
Map 5	C4691VIB-041	B-41	15.0	10.0	OK	3454	2965	16	548
Map 5	C4691VIB-034	B-34	15.0	11.0	OK	1535	2217	15	598
Map 5	C4691VIB-027	B-27	15.0	12.0	OK	2446	2236	20	897
Map 5	C4691VIB-020	B-20	15.0	13.0	OK	1479	1345	25	982
Map 5	C4691VIB-006	B-6	15.0	15.0	OK	100	136	2	235
Map 5	C4683VIB-015	B-15	16.0	0.0	OK	9	104	2	219
Map 5	C4683VIB-010	B-10	16.0	1.0	OK	9	694	2	827
Map 5	C4683VIB-005	B-5	16.0	2.0	OK	9	583	6	943
Map 5	C4691VIB-084	B-84	16.0	4.0	OK	3796	2069	20	854
Map 5	C4691VIB-077	B-77	16.0	5.0	OK	795	980	8	544
Map 5	C4691VIB-070	B-70	16.0	6.0	OK	3169	2097	9	497
Map 5	C4691VIB-063	B-63	16.0	7.0	OK	2848	1226	13	396
Map 5	C4691VIB-056	B-56	16.0	8.0	OK	3424	1345	11	594
Map 5	C4691VIB-049	B-49	16.0	9.0	OK	85	142	5	203
Map 5	C4691VIB-042	B-42	16.0	10.0	OK	4224	2775	27	606
Map 5	C4691VIB-035	B-35	16.0	11.0	OK	2247	3127	15	606
Map 5	C4691VIB-028	B-28	16.0	12.0	OK	2779	2336	18	842
Map 5	C4691VIB-021	B-21	16.0	13.0	OK	2709	2217	16	819
Map 5	C4691VIB-007	B-7	16.0	15.0	OK	138	133	5	190
Map 5	C4691VIN-061	NS-61	17.0	11.0	OK	100	174	5	332
Map 5	C4691VIN-046	NS-46	17.0	12.0	OK	3874	2236	16	594
Map 5	C4691VIN-001	NS-1	17.0	15.0	OK	42	68	2	125
Map 5	C4691VIN-062	NS-62	18.0	11.0	OK	137	181	4	311
Map 5	C4691VIN-047	NS-47	18.0	12.0	OK	3928	2713	16	540
Map 5	C4691VIN-032	NS-32	18.0	13.0	OK	1469	987	20	1125

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 5	C4691VIN-002	NS-2	18.0	15.0	OK	66	105	2	195
Map 5	C4691VIN-063	NS-63	19.0	11.0	OK	6654	2957	24	594
Map 5	C4691VIN-048	NS-48	19.0	12.0	OK	5334	3093	19	582
Map 5	C4691VIN-033	NS-33	19.0	13.0	OK	1464	1296	19	1121
Map 5	C4691VIN-003	NS-3	19.0	15.0	OK	100	66	2	134
Map 5	C4691VIN-064	NS-64	20.0	11.0	OK	11657	3947	26	1083
Map 5	C4691VIN-049	NS-49	20.0	12.0	OK	8898	2991	20	575
Map 5	C4691VIN-034	NS-34	20.0	13.0	OK	1100	870	14	1098
Map 5	C4691VIN-004	NS-4	20.0	15.0	OK	85	178	2	246
Map 5	C4691VIN-065	NS-65	21.0	11.0	OK	9656	5072	26	1284
Map 5	C4691VIN-050	NS-50	21.0	12.0	OK	5048	2625	18	676
Map 5	C4691VIN-035	NS-35	21.0	13.0	OK	1867	1316	18	1203
Map 5	C4691VIN-020	NS-20	21.0	14.0	OK	3218	2616	25	633
Map 5	C4691VIN-005	NS-5	21.0	15.0	OK	60	113	2	193
Map 5	C4691VIN-066	NS-66	22.0	11.0	OK	11913	4680	27	1234
Map 5	C4691VIN-051	NS-51	22.0	12.0	OK	3816	1640	22	633
Map 5	C4691VIN-036	NS-36	22.0	13.0	OK	1054	992	18	990
Map 5	C4691VIN-006	NS-7	22.0	15.0	OK	78	153	2	250
Map 5	C4691VIN-067	NS-67	23.0	11.0	OK	16176	4061	20	1478
Map 5	C4691VIN-052	NS-52	23.0	12.0	OK	7165	3595	18	594
Map 5	C4691VIN-037	NS-37	23.0	13.0	OK	1232	955	20	900
Map 5	C4691VIN-007	NS-8	23.0	15.0	OK	28	218	2	245
Map 5	C4691VIN-068	NS-68	24.0	11.0	OK	5903	4527	21	532
Map 5	C4691VIN-053	NS-53	24.0	12.0	OK	622	813	8	427
Map 5	C4691VIN-038	NS-38	24.0	13.0	OK	515	485	8	749
Map 5	C4691VIN-008	NS-8A	24.0	15.0	OK	73	140	2	249
Map 5	C4691VIN-069	NS-69	25.0	11.0	OK	6701	3706	19	780
Map 5	C4691VIN-054	NS-54	25.0	12.0	OK	1303	1145	10	513
Map 5	C4691VIN-039	NS-39	25.0	13.0	OK	882	842	14	1017
Map 5	C4691VIN-009	NS-9	25.0	15.0	OK	64	141	5	245
Map 5	C4691VIN-070	NS-70	26.0	11.0	OK	3576	2642	22	633
Map 5	C4691VIN-055	NS-55	26.0	12.0	OK	4519	2050	19	513
Map 5	C4691VIN-040	NS-40	26.0	13.0	OK	365	294	4	392
Map 5	C4691VIN-010	NS-10	26.0	15.0	OK	51	123	2	261
Map 5	C4683VIF-007	F-7	27.0	1.0	OK	64	582	5	738
Map 5	C4683VIF-001	F-1	27.0	2.0	OK	127	547	8	784
Map 5	C4691VIF-001	F-1	27.0	9.7	OK	261	540	8	482
Map 5	C4691VIN-071	NS-71	27.0	11.0	OK	3134	2965	16	645
Map 5	C4691VIN-056	NS-56	27.0	12.0	OK	3630	3722	18	536
Map 5	C4691VIN-041	NS-41	27.0	13.0	OK	1666	1395	23	1075
Map 5	C4691VIN-011	NS-11	27.0	15.0	OK	109	155	2	281
Map 5	C4683VIF-014	F-14	28.0	0.0	OK	68	445	7	683
Map 5	C4683VIF-008	F-8	28.0	1.0	OK	68	591	10	687
Map 5	C4683VIF-002	F-2	28.0	2.0	OK	126	290	5	559
Map 5	C4691VIF-017	F-17	28.0	6.7	OK	4904	2263	15	555
Map 5	C4691VIF-012	F-12	28.0	7.7	OK	4952	3152	21	645
Map 5	C4691VIF-002	F-2	28.0	9.7	OK	3311	2400	30	1439
Map 5	C4691VIN-072	NS-72	28.0	11.0	OK	2312	2291	13	567
Map 5	C4691VIN-057	NS-57	28.0	12.0	OK	622	728	12	536
Map 5	C4691VIN-042	NS-42	28.0	13.0	OK	1585	1226	17	1226
Map 5	C4691VIN-012	NS-12	28.0	15.0	OK	83	109	5	206
Map 5	C4683VIF-015	F-15	29.0	0.0	OK	148	402	5	823
Map 5	C4683VIF-009	F-9	29.0	1.0	OK	348	624	14	1025

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 5	C4683VIF-003	F-3	29.0	2.0	OK	540	604	8	1866
Map 5	C4691VIF-038	F-38	29.0	2.5	OK	1054	772	10	815
Map 5	C4691VIF-033	F-33	29.0	3.8	OK	591	905	23	800
Map 5	C4691VIF-028	F-28	29.0	4.8	OK	882	823	19	1544
Map 5	C4691VIF-018	F-18	29.0	6.7	OK	525	499	15	303
Map 5	C4691VIF-013	F-13	29.0	7.7	OK	917	1039	16	614
Map 5	C4691VIF-003	F-3	29.0	9.7	OK	1520	1064	13	668
Map 5	C4691VIN-073	NS-73	29.0	11.0	OK	2322	2236	19	815
Map 5	C4691VIN-058	NS-58	29.0	12.0	OK	2888	3466	24	831
Map 5	C4691VIN-013	NS-13	29.0	15.0	OK	86	65	4	113
Map 5	C4683VIF-017	F-17	31.0	0.0	OK	62	245	7	361
Map 5	C4683VIF-011	F-11	31.0	1.0	OK	55	314	8	303
Map 5	C4683VIF-005	F-5	31.0	2.0	OK	46	268	7	296
Map 5	C4691VIF-040	F-40	31.0	2.5	OK	98	280	5	311
Map 5	C4691VIF-030	F-30	31.0	4.8	OK	1014	1493	15	509
Map 5	C4691VIF-025	F-25	31.0	5.8	OK	1897	1523	16	761
Map 5	C4691VIF-010	F-10	31.0	8.7	OK	2868	2327	18	505
Map 5	C4691VIF-005	F-5	31.0	9.7	OK	7026	2254	18	548
Map 5	C4691VIN-075	NS-75	31.0	11.0	OK	1902	1256	16	532
Map 5	C4691VIN-060	NS-60	31.0	12.0	OK	437	303	8	385
Map 5	C4691VIN-045	NS-45	31.0	13.0	OK	34	265	2	369
Map 5	C4691VIN-015	NS-15	31.0	15.0	OK	3208	2445	16	528
Map 5	C4683VIF-018	F-18	32.0	0.0	OK	83	283	6	350
Map 5	C4683VIF-012	F-12	32.0	1.0	OK	70	198	5	273
Map 5	C4683VIF-006	F-6	32.0	2.0	OK	98	246	6	254
Map 6	C5040STF-001	G001	1.0	1.0	OK	99	209	6	102
Map 6	C5040STF-002	G002	1.0	2.0	OK	129	137	5	78
Map 6	C5040STF-003	G003	1.0	3.0	OK	91	172	6	86
Map 6	C5040STF-004	G004	1.0	4.0	OK	51	135	6	81
Map 6	C5040STF-005	G005	1.0	5.0	OK	98	109	2	71
Map 6	C5040STF-006	G006	1.0	6.0	OK	99	138	7	87
Map 6	C5040STF-007	G007	1.0	7.0	OK	61	160	5	86
Map 6	C5040STS-008	G008	1.0	8.0	OK	133	182	2	82
Map 6	C5040STS-009	G009	1.0	9.0	OK	92	200	2	99
Map 6	C5040STS-010	G010	1.0	10.0	OK	55	73	2	88
Map 6	C5040STS-011	G011	1.0	11.0	OK	71	168	2	109
Map 6	C5040STS-012	G012	1.0	12.0	OK	71	114	5	72
Map 6	C5040STS-013	G013	1.0	13.0	OK	56	58	2	102
Map 6	C5040STB-014	G014	1.0	14.0	OK	54	141	2	91
Map 6	C5040STB-015	G015	1.0	15.0	OK	25	104	2	81
Map 6	C5040STB-016	G016	1.0	16.0	OK	77	176	2	99
Map 6	C5040STB-017	G017	1.0	17.0	OK	19	118	2	94
Map 6	C5040STB-018	G018	1.0	18.0	OK	43	101	4	90
Map 6	C5040STB-019	G019	1.0	19.0	OK	70	92	2	100
Map 6	C5040STB-020	G020	1.0	20.0	OK	30	97	5	131
Map 6	C5040STB-021	G021	1.0	21.0	OK	55	75	4	106
Map 6	C5040STB-022	G022	1.0	22.0	OK	34	103	2	106
Map 6	C5040STF-023	G023	2.0	1.0	OK	92	187	7	107
Map 6	C5040STF-024	G024	2.0	2.0	OK	134	211	6	110
Map 6	C5040STF-025	G025	2.0	3.0	OK	91	150	6	71
Map 6	C5040STF-026	G026	2.0	4.0	OK	62	116	4	69
Map 6	C5040STF-027	G027	2.0	5.0	OK	134	167	6	80
Map 6	C5040STF-028	G028	2.0	6.0	OK	42	98	4	78

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 6	C5040STF-029	G029	2.0	7.0	OK	42	164	4	99
Map 6	C5040STS-030	G030	2.0	8.0	OK	86	90	4	80
Map 6	C5040STS-031	G031	2.0	9.0	OK	48	69	4	81
Map 6	C5040STS-032	G032	2.0	10.0	OK	9	66	2	96
Map 6	C5040STS-033	G033	2.0	11.0	OK	149	141	5	166
Map 6	C5040STS-034	G034	2.0	12.0	OK	37	119	5	107
Map 6	C5040STS-035	G035	2.0	13.0	OK	71	79	2	133
Map 6	C5040STB-036	G036	2.0	14.0	OK	65	158	5	100
Map 6	C5040STB-037	G037	2.0	15.0	OK	91	135	2	81
Map 6	C5040STB-038	G038	2.0	16.0	OK	52	126	2	142
Map 6	C5040STB-039	G039	2.0	17.0	OK	44	112	4	68
Map 6	C5040STB-040	G040	2.0	18.0	OK	66	135	7	78
Map 6	C5040STB-041	G041	2.0	19.0	OK	112	104	2	56
Map 6	C5040STB-042	G042	2.0	20.0	OK	98	98	2	69
Map 6	C5040STB-043	G043	2.0	21.0	OK	49	83	4	75
Map 6	C5040STB-044	G044	2.0	22.0	OK	71	98	4	220
Map 6	C5040STF-045	G045	3.0	1.0	OK	51	134	7	88
Map 6	C5040STF-046	G046	3.0	2.0	OK	69	162	5	84
Map 6	C5040STF-047	G047	3.0	3.0	OK	35	74	2	102
Map 6	C5040STF-048	G048	3.0	4.0	OK	58	81	6	87
Map 6	C5040STF-049	G049	3.0	5.0	OK	64	58	5	63
Map 6	C5040STB-050	G050	3.0	14.0	OK	61	136	6	132
Map 6	C5040STB-051	G051	3.0	15.0	OK	121	158	4	100
Map 6	C5040STB-052	G052	3.0	16.0	OK	183	82	5	72
Map 6	C5040STB-053	G053	3.0	17.0	OK	87	87	2	70
Map 6	C5040STB-054	G054	3.0	18.0	OK	117	105	2	72
Map 6	C5040STB-055	G055	3.0	19.0	OK	90	109	4	70
Map 6	C5040STB-056	G056	3.0	20.0	OK	133	172	5	80
Map 6	C5040STB-057	G057	3.0	21.0	OK	124	84	4	99
Map 6	C5040STB-058	G058	3.0	22.0	OK	34	93	2	90
Map 6	C5040STB-059	G059	3.0	23.0	OK	61	62	5	74
Map 6	C5040STF-060	G060	4.0	1.0	OK	101	175	2	155
Map 6	C5040STF-061	G061	4.0	2.0	OK	52	142	6	87
Map 6	C5040STF-062	G062	4.0	3.0	OK	9	82	5	126
Map 6	C5040STF-063	G063	4.0	4.0	OK	31	99	5	253
Map 6	C5040STF-064	G064	4.0	5.0	OK	65	144	5	78
Map 6	C5040STB-065	G065	4.0	14.0	OK	135	469	5	167
Map 6	C5040STB-066	G066	4.0	15.0	OK	162	97	2	94
Map 6	C5040STB-067	G067	4.0	16.0	OK	105	113	2	84
Map 6	C5040STB-068	G068	4.0	17.0	OK	72	51	4	59
Map 6	C5040STB-069	G069	4.0	18.0	OK	131	92	2	69
Map 6	C5040STB-070	G070	4.0	19.0	OK	106	109	5	63
Map 6	C5040STB-071	G071	4.0	20.0	OK	89	60	2	48
Map 6	C5040STB-072	G072	4.0	21.0	OK	122	98	2	74
Map 6	C5040STB-073	G073	4.0	22.0	OK	87	116	7	93
Map 6	C5040STB-074	G074	4.0	23.0	OK	89	136	2	79
Map 6	C5040STB-075	G075	4.0	24.0	OK	30	80	6	90
Map 6	C5040STB-076	G076	4.0	25.0	OK	54	113	5	113
Map 6	C5040STB-077	G077	4.0	26.0	OK	75	108	5	142
Map 6	C5040STF-078	G078	5.0	1.0	OK	93	146	2	89
Map 6	C5040STF-079	G079	5.0	2.0	OK	81	151	5	89
Map 6	C5040STF-080	G080	5.0	3.0	OK	85	124	2	78
Map 6	C5040STF-081	G081	5.0	4.0	OK	31	85	2	76

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 6	C5040STF-082	G082	5.0	5.0	OK	9	116	4	92
Map 6	C5040STB-083	G083	5.0	17.0	OK	73	58	2	60
Map 6	C5040STB-084	G084	5.0	18.0	OK	89	69	2	46
Map 6	C5040STB-085	G085	5.0	19.0	OK	62	80	2	42
Map 6	C5040STB-086	G086	5.0	20.0	OK	101	105	6	85
Map 6	C5040STB-087	G087	5.0	21.0	OK	102	125	6	72
Map 6	C5040STB-088	G088	5.0	22.0	OK	88	74	2	74
Map 6	C5040STB-089	G089	5.0	23.0	OK	28	104	2	130
Map 6	C5040STB-090	G090	5.0	24.0	OK	112	91	2	74
Map 6	C5040STB-091	G091	5.0	25.0	OK	110	303	8	120
Map 6	C5040STB-092	G092	5.0	26.0	OK	32	97	4	124
Map 6	C5040STF-093	G093	6.0	1.0	OK	44	137	2	88
Map 6	C5040STF-094	G094	6.0	2.0	OK	63	129	5	97
Map 6	C5040STF-095	G095	6.0	3.0	OK	19	126	6	109
Map 6	C5040STF-096	G096	6.0	4.0	OK	82	139	2	82
Map 6	C5040STF-097	G097	6.0	5.0	OK	46	148	5	109
Map 6	C5040STB-098	G098	6.0	17.0	OK	93	161	4	96
Map 6	C5040STB-099	G099	6.0	18.0	OK	53	110	5	174
Map 6	C5040STB-100	G100	6.0	19.0	OK	71	139	5	107
Map 6	C5040STB-101	G101	6.0	20.0	OK	74	84	5	59
Map 6	C5040STB-102	G102	6.0	21.0	OK	124	122	2	69
Map 6	C5040STB-103	G103	6.0	22.0	OK	122	175	2	78
Map 6	C5040STB-104	G104	6.0	23.0	OK	46	93	2	66
Map 6	C5040STB-105	G105	6.0	24.0	OK	119	84	5	72
Map 6	C5040STB-106	G106	6.0	25.0	OK	97	76	4	71
Map 6	C5040STB-107	G107	6.0	26.0	OK	25	101	6	118
Map 6	C5040STF-108	G108	7.0	1.0	OK	118	107	5	129
Map 6	C5040STF-109	G109	7.0	2.0	OK	67	84	2	65
Map 6	C5040STF-110	G110	7.0	3.0	OK	60	58	7	59
Map 6	C5040STF-111	G111	7.0	4.0	OK	37	63	2	60
Map 6	C5040STF-112	G112	7.0	5.0	OK	136	133	6	71
Map 6	C5040STB-113	G113	7.0	17.0	OK	154	197	2	100
Map 6	C5040STB-114	G114	7.0	18.0	OK	86	97	2	140
Map 6	C5040STB-115	G115	7.0	19.0	OK	96	151	5	76
Map 6	C5040STB-116	G116	7.0	20.0	OK	80	104	2	62
Map 6	C5040STB-117	G117	7.0	21.0	OK	120	137	2	55
Map 6	C5040STB-118	G118	7.0	22.0	OK	142	137	5	51
Map 6	C5040STB-119	G119	7.0	23.0	OK	92	109	6	59
Map 6	C5040STB-120	G120	7.0	24.0	OK	56	137	2	61
Map 6	C5040STB-121	G121	7.0	25.0	OK	124	213	6	102
Map 6	C5040STB-122	G122	7.0	26.0	OK	9	118	2	152
Map 6	C5040STC-002	FC-2	7.5	18.5	OK	108	189	2	86
Map 6	C5040STF-123	G123	8.0	1.0	OK	100	142	4	81
Map 6	C5040STF-124	G124	8.0	2.0	OK	80	127	5	98
Map 6	C5040STF-125	G125	8.0	3.0	OK	72	138	5	79
Map 6	C5040STF-126	G126	8.0	4.0	OK	52	81	5	59
Map 6	C5040STF-127	G127	8.0	5.0	OK	114	106	5	89
Map 6	C5040STB-128	G128	8.0	6.0	OK	79	160	6	412
Map 6	C5040STB-129	G129	8.0	7.0	OK	9	90	6	197
Map 6	C5040STB-130	G130	8.0	17.0	OK	98	287	5	158
Map 6	C5040STB-131	G131	8.0	18.0	OK	184	348	5	111
Map 6	C5040STB-132	G132	8.0	19.0	OK	123	157	2	66
Map 6	C5040STB-133	G133	8.0	20.0	OK	148	287	6	90

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 6	C5040STB-134	G134	8.0	21.0	OK	231	413	2	77
Map 6	C5040STB-135	G135	8.0	22.0	OK	120	276	4	101
Map 6	C5040STB-136	G136	8.0	23.0	OK	84	208	4	68
Map 6	C5040STB-137	G137	8.0	24.0	OK	109	237	4	91
Map 6	C5040STB-138	G138	8.0	25.0	OK	133	257	5	116
Map 6	C5040STB-139	G139	8.0	26.0	OK	41	124	2	177
Map 6	C5040STF-140	G140	9.0	1.0	OK	32	133	4	118
Map 6	C5040STF-141	G141	9.0	2.0	OK	55	205	5	104
Map 6	C5040STF-142	G142	9.0	3.0	OK	49	75	2	57
Map 6	C5040STF-143	G143	9.0	4.0	OK	40	70	6	54
Map 6	C5040STF-144	G144	9.0	5.0	OK	131	147	7	112
Map 6	C5040STF-145	G145	9.0	6.0	OK	81	80	2	136
Map 6	C5040STF-146	G146	9.0	7.0	OK	9	129	4	170
Map 6	C5040STC-001	FC-1	9.5	2.5	OK	57	207	6	107
Map 6	C5040STF-147	G147	10.0	1.0	OK	57	226	5	104
Map 6	C5040STF-148	G148	10.0	2.0	OK	47	264	6	129
Map 6	C5040STF-149	G149	10.0	3.0	OK	63	223	5	119
Map 6	C5040STF-150	G150	10.0	4.0	OK	113	266	7	158
Map 6	C5040STF-151	G151	10.0	5.0	OK	113	173	5	183
Map 6	C5040STF-152	G152	10.0	6.0	OK	9	115	6	190
Map 6	C5040STF-153	G153	10.0	7.0	OK	9	140	4	621
Map 6	C5040STB-154	G154	10.0	15.0	OK	9	80	2	174
Map 6	C5040STB-155	G155	10.0	16.0	OK	58	92	6	262
Map 6	C5040STB-156	G156	10.0	17.0	OK	89	159	6	125
Map 6	C5040STB-157	G157	10.0	18.0	OK	57	149	8	73
Map 6	C5040STB-158	G158	10.0	19.0	OK	78	187	5	98
Map 6	C5040STB-159	G159	10.0	20.0	OK	88	140	5	83
Map 6	C5040STB-160	G160	10.0	21.0	OK	48	158	6	83
Map 6	C5040STB-161	G161	10.0	22.0	OK	55	151	8	105
Map 6	C5040STB-162	G162	10.0	23.0	OK	61	134	6	84
Map 6	C5040STB-163	G163	10.0	24.0	OK	51	159	8	103
Map 6	C5040STB-164	G164	10.0	25.0	OK	9	101	2	111
Map 6	C5040STB-165	G165	10.0	26.0	OK	9	92	2	164
Map 6	C5040STB-166	G166	11.0	15.0	OK	116	241	7	178
Map 6	C5040STB-167	G167	11.0	16.0	OK	9	214	2	247
Map 6	C5040STB-168	G168	11.0	17.0	OK	60	157	4	102
Map 6	C5040STB-169	G169	11.0	18.0	OK	67	122	5	79
Map 6	C5040STB-170	G170	11.0	19.0	OK	94	172	5	88
Map 6	C5040STB-171	G171	11.0	20.0	OK	9	128	5	97
Map 6	C5040STB-172	G172	11.0	21.0	OK	95	125	6	101
Map 6	C5040STB-173	G173	11.0	22.0	OK	100	145	7	112
Map 6	C5040STB-174	G174	11.0	23.0	OK	87	138	5	88
Map 6	C5040STB-175	G175	11.0	24.0	OK	84	170	2	110
Map 6	C5040STB-176	G176	11.0	25.0	OK	46	109	4	158
Map 6	C5040STB-177	G177	12.0	15.0	OK	33	96	6	358
Map 6	C5040STB-178	G178	12.0	16.0	OK	46	116	2	313
Map 6	C5040STB-179	G179	12.0	17.0	OK	27	83	2	303
Map 6	C5040STB-180	G180	12.0	18.0	OK	9	94	2	228
Map 6	C5040STB-181	G181	12.0	19.0	OK	47	60	2	232
Map 6	C5040STB-182	G182	12.0	20.0	OK	27	91	2	244
Map 6	C5040STB-183	G183	12.0	21.0	OK	9	83	4	238
Map 6	C5040STB-184	G184	12.0	22.0	OK	54	79	2	216
Map 6	C5040STB-185	G185	12.0	23.0	OK	9	92	2	220

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 6	C5040STB-186	G186	12.0	24.0	OK	75	95	2	220
Map 6	C5040STB-187	G187	12.0	25.0	OK	9	95	2	244
Map 6	C5030STF-188	G188	14.0	1.0	OK	85	161	9	103
Map 6	C5030STF-189	G189	14.0	2.0	OK	130	127	6	164
Map 6	C5030STF-190	G190	14.0	3.0	OK	100	119	5	169
Map 6	C5030STF-191	G191	14.0	4.0	OK	126	150	7	151
Map 6	C5030STF-192	G192	14.0	5.0	OK	154	150	6	137
Map 6	C5030STF-193	G193	14.0	6.0	OK	129	124	8	150
Map 6	C5030STF-194	G194	14.0	7.0	OK	87	77	4	123
Map 6	C5030STN-195	G195	14.0	9.0	OK	42	94	8	67
Map 6	C5030STN-196	G196	14.0	10.0	OK	35	66	2	60
Map 6	C5030STN-197	G197	14.0	11.0	OK	33	81	2	56
Map 6	C5030STN-198	G198	14.0	12.0	OK	67	60	2	57
Map 6	C5030STN-199	G199	14.0	13.0	OK	29	57	5	58
Map 6	C5030STN-200	G200	14.0	14.0	OK	44	65	2	56
Map 6	C5030STN-201	G201	14.0	15.0	OK	23	39	2	70
Map 6	C5030STN-202	G202	14.0	16.0	OK	25	71	2	135
Map 6	C5030STN-203	G203	14.0	17.0	OK	19	45	4	62
Map 6	C5030STB-204	G204	14.0	18.0	OK	9	57	2	65
Map 6	C5030STB-205	G205	14.0	19.0	OK	56	61	4	50
Map 6	C5030STB-206	G206	14.0	20.0	OK	9	37	2	57
Map 6	C5030STB-207	G207	14.0	21.0	OK	26	68	2	100
Map 6	C5030STB-208	G208	14.0	22.0	OK	98	88	4	79
Map 6	C5030STB-209	G209	14.0	23.0	OK	71	76	7	78
Map 6	C5030STB-210	G210	14.0	24.0	OK	22	67	6	76
Map 6	C5030STB-211	G211	14.0	25.0	OK	189	106	5	105
Map 6	C5030STF-212	G212	15.0	1.0	OK	106	131	5	147
Map 6	C5030STF-213	G213	15.0	2.0	OK	151	138	6	138
Map 6	C5030STF-214	G214	15.0	3.0	OK	179	139	6	158
Map 6	C5030STF-215	G215	15.0	4.0	OK	343	273	7	176
Map 6	C5030STF-216	G216	15.0	5.0	OK	83	58	2	68
Map 6	C5030STF-217	G217	15.0	6.0	OK	112	128	7	111
Map 6	C5030STB-218	G218	15.0	18.0	OK	69	74	4	111
Map 6	C5030STB-219	G219	15.0	19.0	OK	137	84	2	97
Map 6	C5030STB-220	G220	15.0	20.0	OK	102	107	2	99
Map 6	C5030STB-221	G221	15.0	21.0	OK	105	84	2	87
Map 6	C5030STB-222	G222	15.0	22.0	OK	108	64	4	71
Map 6	C5030STB-223	G223	15.0	23.0	OK	132	64	6	62
Map 6	C5030STB-224	G224	15.0	24.0	OK	104	83	4	81
Map 6	C5030STB-225	G225	15.0	25.0	OK	123	69	2	71
Map 7	C4714JOF-007	FA-007	2.0	1.0	OK	54	310	8	780
Map 7	C4714JOF-008	FA-008	2.0	2.0	OK	50	202	2	385
Map 7	C4714JOF-004	FA-004	4.0	1.0	OK	65	122	6	249
Map 7	C4714JOF-005	FA-005	4.0	2.0	OK	9	168	5	327
Map 7	C4714JOF-006	FA-006	4.0	6.0	OK	46	191	6	221
Map 7	C4714JOB-009	FA-009	4.0	23.0	OK	9	178	4	349
Map 7	C4714JOB-010	FA-010	4.0	22.0	OK	25	201	2	346
Map 7	C4714JOB-011	FA-011	4.0	21.0	OK	9	194	2	327
Map 7	C4714JOB-012	FA-012	5.0	23.0	OK	49	243	7	458
Map 7	C4714JOB-013	FA-013	5.0	22.0	OK	42	261	4	505
Map 7	C4714JOB-014	FA-014	5.0	21.0	OK	9	219	5	335
Map 7	C4714JOF-001	FA-001	6.0	1.0	OK	9	264	6	893
Map 7	C4714JOF-002	FA-002	6.0	2.0	OK	101	272	6	513

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 7	C4714JOF-003	FA-003	6.0	6.0	OK	55	207	5	261
Map 7	C4714JOB-015	FA-015	6.0	23.0	OK	9	261	7	629
Map 7	C4714JOB-016	FA-016	6.0	22.0	OK	46	273	2	648
Map 7	C4714JOB-017	FA-017	6.0	21.0	OK	9	234	4	478
Map 7	C4712JOF-001	F001	8.0	1.0	OK	9	351	9	1036
Map 7	C4712JOF-002	F002	8.0	6.0	OK	29	317	6	555
Map 7	C4712JOF-003	F003	8.0	7.0	OK	52	223	12	501
Map 7	C5040STF-004	F004	8.0	8.0	OK	51	250	7	349
Map 7	C4712JOF-005	F005	8.0	9.0	OK	49	310	8	381
Map 7	C4712JOF-006	F006	8.0	10.0	OK	44	260	2	310
Map 7	C4712JOF-007	F007	8.0	11.0	OK	9	215	4	282
Map 7	C4712JOF-008	F008	8.0	12.0	OK	38	191	6	385
Map 7	C4712JOF-009	F009	8.0	13.0	OK	123	268	7	400
Map 7	C4712JOF-010	F010	8.0	14.0	OK	9	214	5	281
Map 7	C4712JOF-011	F011	8.0	15.0	OK	9	258	8	278
Map 7	C4712JOF-012	F012	8.0	16.0	OK	37	287	5	314
Map 7	C4712JOF-013	F013	8.0	17.0	OK	62	306	7	285
Map 7	C4712JOF-014	F014	8.0	18.0	OK	98	469	6	486
Map 7	C4712JOF-015	F015	8.0	19.0	OK	9	483	7	478
Map 7	C4712JOF-016	F016	8.0	20.0	OK	62	177	6	177
Map 7	C4712JOF-017	F017	8.0	21.0	OK	88	254	5	284
Map 7	C4712JOB-018	F018	8.0	22.0	OK	43	179	2	244
Map 7	C4712JOB-019	F019	8.0	23.0	OK	9	255	4	455
Map 7	C4712JOF-020	F020	9.0	1.0	OK	61	391	7	819
Map 7	C4712JOF-021	F021	9.0	6.0	OK	149	338	8	594
Map 7	C4712JOF-022	F022	9.0	7.0	OK	42	199	8	439
Map 7	C4712JOF-023	F023	9.0	8.0	OK	58	213	6	251
Map 7	C4712JOF-024	F024	9.0	9.0	OK	51	232	7	439
Map 7	C4712JOF-025	F025	9.0	10.0	OK	19	324	5	238
Map 7	C4712JOF-026	F026	9.0	11.0	OK	9	147	5	224
Map 7	C4712JOF-027	F027	9.0	12.0	OK	40	159	2	232
Map 7	C4712JOF-028	F028	9.0	13.0	OK	18	167	2	174
Map 7	C4712JOF-029	F029	9.0	14.0	OK	40	176	6	210
Map 7	C4712JOF-030	F030	9.0	15.0	OK	38	228	4	201
Map 7	C4712JOF-031	F031	9.0	16.0	OK	28	200	5	263
Map 7	C4712JOF-032	F032	9.0	17.0	OK	29	230	5	282
Map 7	C4712JOF-033	F033	9.0	18.0	OK	51	289	6	350
Map 7	C4712JOF-034	F034	9.0	19.0	OK	68	432	5	350
Map 7	C4712JOF-035	F035	9.0	20.0	OK	29	348	4	304
Map 7	C4712JOF-036	F036	9.0	21.0	OK	101	333	5	358
Map 7	C4712JOB-037	F037	9.0	22.0	OK	82	286	4	327
Map 7	C4712JOB-038	F038	9.0	23.0	OK	39	344	6	528
Map 7	C4712JOF-039	F039	10.0	1.0	OK	9	313	18	470
Map 7	C4712JOF-040	F040	10.0	6.0	OK	83	340	6	520
Map 7	C4712JOF-041	F041	10.0	7.0	OK	68	234	19	501
Map 7	C4712JOF-042	F042	10.0	8.0	OK	56	285	6	373
Map 7	C4712JOF-043	F043	10.0	9.0	OK	9	257	5	268
Map 7	C4712JOF-044	F044	10.0	10.0	OK	63	189	5	225
Map 7	C4712JOF-045	F045	10.0	11.0	OK	9	154	7	234
Map 7	C4712JOF-046	F046	10.0	12.0	OK	9	145	2	250
Map 7	C4712JOF-047	F047	10.0	13.0	OK	33	149	5	197
Map 7	C4712JOF-048	F048	10.0	14.0	OK	28	206	5	257
Map 7	C4712JOF-049	F049	10.0	15.0	OK	9	212	5	273

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 7	C4712JOF-050	F050	10.0	16.0	OK	51	243	5	299
Map 7	C4712JOF-051	F051	10.0	17.0	OK	9	253	8	354
Map 7	C4712JOF-052	F052	10.0	18.0	OK	9	253	6	315
Map 7	C4712JOF-053	F053	10.0	19.0	OK	42	269	7	344
Map 7	C4712JOF-054	F054	10.0	20.0	OK	76	262	6	229
Map 7	C4712JOF-055	F055	10.0	21.0	OK	105	337	5	318
Map 7	C4712JOF-056	F056	10.0	22.0	OK	121	376	6	361
Map 7	C4712JOF-057	F057	10.0	23.0	OK	45	297	15	350
Map 7	C4712JOF-058	F058	11.0	1.0	OK	71	403	8	811
Map 7	C4712JOF-059	F059	11.0	6.0	OK	120	334	9	513
Map 7	C4712JOF-060	F060	11.0	7.0	OK	33	227	15	617
Map 7	C4712JOF-061	F061	11.0	8.0	OK	9	257	11	346
Map 7	C4712JOF-062	F062	11.0	9.0	OK	68	373	9	614
Map 7	C4712JOF-063	F063	11.0	10.0	OK	59	230	6	308
Map 7	C4712JOF-064	F064	11.0	11.0	OK	48	121	5	224
Map 7	C4712JOF-065	F065	11.0	12.0	OK	68	161	5	251
Map 7	C4712JOF-066	F066	11.0	13.0	OK	24	161	6	202
Map 7	C4712JOF-067	F067	11.0	14.0	OK	50	161	8	190
Map 7	C4712JOF-068	F068	11.0	15.0	OK	25	166	2	204
Map 7	C4712JOF-069	F069	11.0	16.0	OK	91	269	7	266
Map 7	C4712JOF-070	F070	11.0	17.0	OK	57	219	7	283
Map 7	C4712JOF-071	F071	11.0	18.0	OK	35	216	5	252
Map 7	C4712JOF-072	F072	11.0	19.0	OK	44	237	11	256
Map 7	C4712JOF-073	F073	11.0	20.0	OK	91	277	6	259
Map 7	C4712JOF-074	F074	11.0	21.0	OK	76	241	6	251
Map 7	C4712JOB-075	F075	11.0	22.0	OK	21	257	5	311
Map 7	C4712JOB-076	F076	11.0	23.0	OK	82	353	8	385
Map 7	C4712JOC-1	FC-1	11.0	11.5	OK	123	438	8	827
Map 7	C4712JOF-077	F077	12.0	1.0	OK	85	361	8	579
Map 7	C4712JOF-078	F078	12.0	6.0	OK	141	353	9	509
Map 7	C4712JOF-079	F079	12.0	7.0	OK	9	189	7	540
Map 7	C4712JOF-080	F080	12.0	8.0	OK	9	356	7	451
Map 7	C4712JOF-081	F081	12.0	9.0	OK	9	174	5	316
Map 7	C4712JOF-082	F082	12.0	10.0	OK	9	329	8	532
Map 7	C4712JOF-083	F083	12.0	11.0	OK	39	244	5	326
Map 7	C4712JOF-089	F089	12.0	17.0	OK	9	423	7	412
Map 7	C4712JOF-090	F090	12.0	18.0	OK	48	185	5	229
Map 7	C4712JOF-091	F091	12.0	19.0	OK	63	212	6	242
Map 7	C4712JOF-092	F092	12.0	20.0	OK	27	356	4	350
Map 7	C4712JOF-093	F093	12.0	21.0	OK	9	214	4	300
Map 7	C4712JOB-094	F094	12.0	22.0	OK	20	293	9	408
Map 7	C4712JOB-095	F095	12.0	23.0	OK	22	298	6	451
Map 7	C4712JOF-084	F084	12.0	12.0	OK	72	290	7	328
Map 7	C4712JOF-085	F085	12.0	13.0	OK	9	331	6	462
Map 7	C4712JOF-086	F086	12.0	14.0	OK	109	369	7	656
Map 7	C4712JOF-087	F087	12.0	15.0	OK	32	316	8	455
Map 7	C4712JOF-088	F088	12.0	16.0	OK	9	218	8	489
Map 7	C4712JOF-096	F096	13.0	1.0	OK	9	320	9	489
Map 7	C4712JOB-097	F097	13.0	23.0	OK	9	411	6	637
Map 7	C4712JOB-098	F098	13.0	24.0	OK	9	306	5	652
Map 7	C4712JOB-099	F099	13.0	25.0	OK	28	348	6	672
Map 7	C4712JOB-100	F100	13.0	26.0	OK	117	427	9	695
Map 7	C4712JOB-101	F101	13.0	27.0	OK	119	325	9	482

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 7	C4712JOB-102	F102	13.0	28.0	OK	9	454	8	730
Map 7	C4712JOF-103	F103	14.0	1.0	OK	9	240	6	334
Map 7	C4712JOB-104	F104	14.0	23.0	OK	32	260	5	345
Map 7	C4712JOB-105	F105	14.0	24.0	OK	55	376	9	594
Map 7	C4712JOB-106	F106	14.0	25.0	OK	9	408	5	451
Map 7	C4712JOB-107	F107	14.0	26.0	OK	164	419	13	858
Map 7	C4712JOB-108	F108	14.0	27.0	OK	87	350	8	730
Map 7	C4712JOC-2	FC-2	14.5	1.0	OK	9	181	6	245
Map 7	C4712JOF-109	F109	15.0	1.0	OK	9	432	7	579
Map 7	C4712JOB-110	F110	15.0	23.0	OK	37	377	8	590
Map 7	C4712JOB-111	F111	15.0	24.0	OK	87	464	8	586
Map 7	C4712JOB-112	F112	15.0	25.0	OK	9	475	10	590
Map 7	C4712JOB-113	F113	15.0	26.0	OK	28	479	5	354
Map 7	C4712JOB-114	F114	15.0	27.0	OK	129	498	9	858
Map 7	C4712JOF-115	F115	16.0	1.0	OK	84	420	9	796
Map 8	C4809MIB-004	A004	0.0	8.0	OK	1600	596	16	381
Map 8	C4809MIB-005	A005	0.0	9.0	OK	350	295	10	493
Map 8	C4809MIB-006	A006	0.0	10.0	OK	1530	435	12	200
Map 8	C4809MIB-007	A007	0.0	11.0	OK	4798	877	12	302
Map 8	C4809MIB-008	A008	0.0	12.0	OK	1837	437	10	361
Map 8	C4809MIF-009	A009	0.0	19.0	OK	428	336	10	239
Map 8	C4809MIF-010	A0010	0.0	20.0	OK	800	485	17	232
Map 8	C4809MIF-011	A011	0.0	21.0	OK	704	456	10	201
Map 8	C4809MIF-012	A012	0.0	22.0	OK	688	399	9	178
Map 8	C4809MIF-013	A013	0.0	23.0	OK	933	444	10	244
Map 8	C4809MIF-014	A014	0.0	24.0	OK	627	458	7	178
Map 8	C4809MIF-015	A015	0.0	25.0	OK	436	320	8	164
Map 8	C4809MIB-001	A001	0.0	2.0	OK	27	141	6	260
Map 8	C4809MIB-002	A002	0.0	3.0	OK	45	128	5	246
Map 8	C4809MIB-003	A003	0.0	4.0	OK	9	114	5	181
Map 8	C4809MIB-016	A016	1.0	2.0	OK	81	128	6	240
Map 8	C4809MIB-017	A017	1.0	3.0	OK	9	146	4	191
Map 8	C4809MIB-018	A018	1.0	4.0	OK	394	346	8	582
Map 8	C4809MIB-019	A019	1.0	8.0	OK	458	644	19	474
Map 8	C4809MIB-020	A020	1.0	9.0	OK	673	740	13	396
Map 8	C4809MIB-021	A021	1.0	10.0	OK	540	386	13	267
Map 8	C4809MIB-022	A022	1.0	11.0	OK	486	405	13	317
Map 8	C4809MIB-023	A023	1.0	12.0	OK	218	317	9	497
Map 8	C4809MIB-024	A024	1.0	13.0	OK	255	526	11	509
Map 8	C4809MIS-025	A025	1.0	14.0	OK	272	623	13	819
Map 8	C4809MIS-026	A026	1.0	15.0	OK	258	355	17	474
Map 8	C4809MIS-027	A027	1.0	16.0	OK	304	353	10	327
Map 8	C4809MIS-028	A028	1.0	17.0	OK	550	392	14	381
Map 8	C4809MIS-029	A029	1.0	18.0	OK	1267	686	16	439
Map 8	C4809MIF-030	A030	1.0	19.0	OK	785	700	17	365
Map 8	C4809MIF-031	A031	1.0	20.0	OK	270	331	11	350
Map 8	C4809MIF-032	A032	1.0	21.0	OK	125	257	7	214
Map 8	C4809MIF-033	A033	1.0	22.0	OK	190	328	9	295
Map 8	C4809MIF-034	A034	1.0	23.0	OK	436	434	10	252
Map 8	C4809MIB-035	A035	2.0	2.0	OK	27	172	7	322
Map 8	C4809MIB-036	A036	2.0	3.0	OK	44	201	6	381
Map 8	C4809MIB-037	A037	2.0	4.0	OK	9	250	11	904
Map 8	C4809MIB-038	A038	2.0	8.0	OK	229	436	9	361

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 8	C4809MIB-039	A039	2.0	9.0	OK	283	343	11	232
Map 8	C4809MIB-040	A040	2.0	10.0	OK	192	500	8	195
Map 8	C4809MIB-041	A041	2.0	11.0	OK	282	321	8	156
Map 8	C4809MIB-042	A042	2.0	12.0	OK	323	260	8	168
Map 8	C4809MIB-043	A043	2.0	13.0	OK	218	166	9	156
Map 8	C4809MIS-044	A044	2.0	14.0	OK	437	253	6	200
Map 8	C4809MIS-045	A045	2.0	15.0	OK	182	537	15	536
Map 8	C4809MIS-046	A046	2.0	16.0	OK	285	396	8	332
Map 8	C4809MIS-047	A047	2.0	17.0	OK	224	303	9	260
Map 8	C4809MIS-048	A048	2.0	18.0	OK	535	447	14	242
Map 8	C4809MIF-049	A049	2.0	19.0	OK	199	455	9	257
Map 8	C4809MIF-050	A050	2.0	20.0	OK	246	423	9	249
Map 8	C4809MIF-051	A051	2.0	21.0	OK	140	209	9	204
Map 8	C4809MIF-052	A052	2.0	22.0	OK	135	259	10	224
Map 8	C4809MIF-053	A053	2.0	23.0	OK	49	189	8	201
Map 8	C4801MIB-001	001	4.0	1.0	OK	9	239	5	327
Map 8	C4801MIB-002	002	4.0	2.0	OK	9	213	8	594
Map 8	C4801MIB-003	003	4.0	3.0	OK	33	202	7	532
Map 8	C4801MIB-004	004	4.0	4.0	OK	39	216	5	404
Map 8	C4801MIB-005	005	4.0	5.0	OK	54	286	7	373
Map 8	C4801MIB-006	006	4.0	6.0	OK	89	175	6	221
Map 8	C4801MIB-007	007	4.0	7.0	OK	56	172	8	218
Map 8	C4801MIB-008	008	4.0	8.0	OK	104	190	8	212
Map 8	C4801MIB-009	009	4.0	9.0	OK	137	194	10	320
Map 8	C4801MIB-010	010	4.0	10.0	OK	165	248	10	223
Map 8	C4801MIB-011	011	4.0	11.0	OK	106	175	9	187
Map 8	C4801MIB-012	012	4.0	12.0	OK	191	271	8	221
Map 8	C4801MIB-013	013	4.0	13.0	OK	74	568	10	1172
Map 8	C4801MIB-014	014	5.0	1.0	OK	9	200	5	346
Map 8	C4801MIB-015	015	5.0	6.0	OK	76	192	7	221
Map 8	C4801MIB-016	016	5.0	7.0	OK	112	138	9	169
Map 8	C4801MIB-017	017	5.0	8.0	OK	224	218	11	208
Map 8	C4801MIB-018	018	5.0	9.0	OK	421	247	7	219
Map 8	C4801MIB-019	019	5.0	10.0	OK	181	212	7	173
Map 8	C4801MIB-020	020	5.0	11.0	OK	152	255	10	187
Map 8	C4801MIB-021	021	5.0	12.0	OK	84	349	5	282
Map 8	C4801MIB-022	022	5.0	13.0	OK	42	197	9	305
Map 8	C4801MIB-025	025	6.0	8.0	OK	261	219	9	206
Map 8	C4801MIB-026	026	6.0	9.0	OK	246	223	9	175
Map 8	C4801MIB-027	027	6.0	10.0	OK	199	189	7	149
Map 8	C4801MIB-028	028	6.0	11.0	OK	181	259	9	175
Map 8	C4801MIB-029	029	6.0	12.0	OK	492	260	11	215
Map 8	C4801MIB-030	030	6.0	13.0	OK	9	154	8	329
Map 8	C4801MIF-031	031	6.0	19.0	OK	179	164	9	275
Map 8	C4801MIF-032	032	6.0	20.0	OK	242	165	10	181
Map 8	C4801MIF-033	033	6.0	21.0	OK	345	133	8	133
Map 8	C4801MIF-034	034	6.0	22.0	OK	423	159	8	139
Map 8	C4801MIF-035	035	6.0	23.0	OK	338	187	6	147
Map 8	C4801MIF-036	036	6.0	24.0	OK	414	167	8	115
Map 8	C4801MIF-037	037	6.0	25.0	OK	399	182	8	166
Map 8	C4801MIB-023	023	6.0	6.0	OK	264	286	8	258
Map 8	C4801MIB-024	024	6.0	7.0	OK	279	242	7	177
Map 8	C4809MIF-C1	BC-1	6.5	24.0	OK	499	225	7	135

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 8	C4809MIB-C2	BC-2	6.5	13.0	OK	191	192	9	142
Map 8	C4801MIB-038	038	7.0	6.0	OK	164	203	8	185
Map 8	C4801MIB-039	039	7.0	7.0	OK	330	228	6	178
Map 8	C4801MIB-040	040	7.0	8.0	OK	246	222	9	186
Map 8	C4801MIB-041	041	7.0	9.0	OK	311	185	9	239
Map 8	C4801MIB-042	042	7.0	10.0	OK	250	268	8	281
Map 8	C4801MIB-043	043	7.0	11.0	OK	428	280	11	195
Map 8	C4801MIB-044	044	7.0	12.0	OK	188	148	6	166
Map 8	C4801MIB-045	045	7.0	13.0	OK	40	321	6	959
Map 8	C4801MIF-046	046	7.0	19.0	OK	262	191	8	318
Map 8	C4801MIF-047	047	7.0	20.0	OK	323	205	9	196
Map 8	C4801MIF-048	048	7.0	21.0	OK	289	139	7	129
Map 8	C4801MIF-049	049	7.0	22.0	OK	395	176	7	171
Map 8	C4801MIF-050	050	7.0	23.0	OK	368	164	8	149
Map 8	C4801MIF-051	051	7.0	24.0	OK	258	151	5	122
Map 8	C4801MIF-052	052	7.0	25.0	OK	276	120	6	91
Map 8	C4801MIB-053	053	10.0	6.0	OK	211	259	7	325
Map 8	C4801MIB-054	054	10.0	7.0	OK	220	241	7	204
Map 8	C4801MIB-055	055	10.0	8.0	OK	297	233	7	157
Map 8	C4801MIB-056	056	10.0	9.0	OK	340	219	6	182
Map 8	C4801MIB-057	057	10.0	10.0	OK	342	246	8	242
Map 8	C4801MIB-058	058	10.0	11.0	OK	297	195	9	176
Map 8	C4801MIF-059	059	10.0	19.0	OK	120	184	10	317
Map 8	C4801MIF-060	060	10.0	20.0	OK	348	231	7	201
Map 8	C4801MIF-061	061	10.0	21.0	OK	253	168	11	178
Map 8	C4801MIF-062	062	10.0	22.0	OK	340	174	10	163
Map 8	C4801MIF-063	063	10.0	23.0	OK	233	165	10	154
Map 8	C4801MIF-064	064	10.0	24.0	OK	299	207	9	176
Map 8	C4801MIF-065	065	10.0	25.0	OK	378	240	9	173
Map 8	C4801MIB-066	066	11.0	6.0	OK	317	178	7	192
Map 8	C4801MIB-067	067	11.0	7.0	OK	246	209	7	159
Map 8	C4801MIB-068	068	11.0	8.0	OK	287	249	7	150
Map 8	C4801MIB-069	069	11.0	9.0	OK	491	337	13	625
Map 8	C4801MIB-070	070	11.0	10.0	OK	627	253	8	217
Map 8	C4801MIB-071	071	11.0	11.0	OK	586	404	7	385
Map 8	C4801MIF-072	072	11.0	19.0	OK	351	226	8	190
Map 8	C4801MIF-073	073	11.0	20.0	OK	259	219	9	180
Map 8	C4801MIF-074	074	11.0	21.0	OK	520	198	9	176
Map 8	C4801MIF-075	075	11.0	23.0	OK	295	142	7	145
Map 8	C4801MIF-076	076	11.0	24.0	OK	540	199	8	174
Map 8	C4801MIF-077	077	11.0	25.0	OK	391	258	8	214
Map 8	C4801MIB-078	078	12.0	2.0	OK	190	264	7	287
Map 8	C4801MIB-079	079	12.0	3.0	OK	113	174	7	280
Map 8	C4801MIB-080	080	12.0	4.0	OK	185	217	5	236
Map 8	C4801MIB-081	081	12.0	6.0	OK	356	190	5	138
Map 8	C4801MIB-082	082	12.0	7.0	OK	224	199	5	120
Map 8	C4801MIB-083	083	12.0	8.0	OK	392	255	11	150
Map 8	C4801MIB-084	084	12.0	9.0	OK	1257	635	11	201
Map 8	C4801MIB-085	085	12.0	10.0	OK	1115	278	11	194
Map 8	C4801MIB-086	086	12.0	11.0	OK	1716	348	8	214
Map 8	C4801MIF-087	087	12.0	19.0	OK	841	162	5	133
Map 8	C4801MIF-088	088	12.0	20.0	OK	177	75	4	75
Map 8	C4801MIF-089	089	12.0	21.0	OK	316	237	9	160

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 8	C4801MIF-090	090	12.0	22.0	OK	213	124	8	113
Map 8	C4801MIF-091	091	12.0	23.0	OK	198	129	6	109
Map 8	C4801MIF-092	092	12.0	24.0	OK	303	198	8	235
Map 8	C4801MIF-093	093	12.0	25.0	OK	145	160	4	138
Map 8	C4801MIB-094	094	13.0	2.0	OK	136	195	5	239
Map 8	C4801MIB-095	095	13.0	3.0	OK	113	149	6	151
Map 8	C4801MIB-096	096	13.0	4.0	OK	118	139	5	190
Map 8	C4801MIB-097	097	13.0	6.0	OK	240	116	5	111
Map 8	C4801MIB-098	098	13.0	7.0	OK	343	197	9	130
Map 8	C4801MIB-099	099	13.0	8.0	OK	235	214	8	144
Map 8	C4801MIB-100	100	13.0	9.0	OK	698	245	10	157
Map 8	C4801MIB-101	101	13.0	10.0	OK	201	249	10	302
Map 8	C4801MIB-102	102	13.0	11.0	OK	811	309	11	365
Map 8	C4801MIF-103	103	13.0	19.0	OK	795	418	10	287
Map 8	C4801MIF-104	104	13.0	20.0	OK	161	50	2	84
Map 8	C4801MIF-105	105	13.0	21.0	OK	169	51	2	65
Map 8	C4801MIF-106	106	13.0	22.0	OK	394	124	5	133
Map 8	C4801MIF-107	107	13.0	23.0	OK	337	149	5	137
Map 8	C4801MIF-108	108	13.0	24.0	OK	310	197	5	135
Map 8	C4801MIF-109	109	13.0	25.0	OK	176	193	8	173
Map 8	C4801MIB-110	110	14.0	2.0	OK	117	167	6	226
Map 8	C4801MIB-111	111	14.0	3.0	OK	66	64	4	104
Map 8	C4801MIB-112	112	14.0	4.0	OK	243	173	6	138
Map 8	C4801MIB-113	113	14.0	6.0	OK	299	162	7	138
Map 8	C4801MIB-114	114	14.0	7.0	OK	378	228	5	162
Map 8	C4801MIB-115	115	14.0	8.0	OK	268	204	6	149
Map 8	C4801MIB-116	116	14.0	9.0	OK	647	284	7	207
Map 8	C4801MIB-117	117	14.0	10.0	OK	156	222	7	358
Map 8	C4801MIB-118	118	14.0	11.0	OK	1171	563	13	807
Map 8	C4801MIF-119	119	14.0	19.0	OK	9	410	7	200
Map 8	C4801MIF-120	120	14.0	20.0	OK	159	260	5	141
Map 8	C4801MIF-121	121	14.0	21.0	OK	157	84	2	95
Map 8	C4801MIF-122	122	14.0	22.0	OK	148	180	7	143
Map 8	C4801MIF-123	123	14.0	23.0	OK	138	244	5	188
Map 8	C4801MIF-124	124	14.0	24.0	OK	59	195	2	194
Map 8	C4801MIF-125	125	14.0	25.0	OK	70	197	5	235
Map 8	C4801MIB-126	126	15.0	2.0	OK	39	230	2	197
Map 8	C4801MIB-127	127	15.0	3.0	OK	49	229	4	270
Map 8	C4801MIB-128	128	15.0	4.0	OK	43	195	5	280
Map 8	C4801MIB-129	129	15.0	6.0	OK	77	180	6	179
Map 8	C4801MIB-130	130	15.0	7.0	OK	149	181	8	242
Map 8	C4801MIB-131	131	15.0	8.0	OK	219	214	5	294
Map 8	C4801MIB-132	132	15.0	9.0	OK	67	167	5	182
Map 8	C4801MIB-133	133	15.0	10.0	OK	91	212	7	200
Map 8	C4801MIB-134	134	15.0	11.0	OK	117	208	5	282
Map 8	C4801MIS-135	135	15.0	14.0	OK	9	286	6	289
Map 8	C4801MIS-136	136	15.0	15.0	OK	19	200	4	222
Map 8	C4801MIS-137	137	15.0	16.0	OK	9	202	2	265
Map 8	C4801MIS-138	138	15.0	17.0	OK	9	209	4	285
Map 8	C4801MIS-139	139	15.0	18.0	OK	35	216	6	350
Map 8	C4801MIF-140	140	15.0	19.0	OK	34	243	5	265
Map 8	C4801MIF-141	141	15.0	20.0	OK	88	184	6	148
Map 8	C4801MIF-142	142	15.0	21.0	OK	141	272	6	164

Map Coordinates and Concentration Values for Surface soils from 8 Residential Properties

Map #	Field ID	CAD ID	X-Coord	Y-Coord	Concentration (ppm)				
						As	Pb	Cd	Zn
Map 8	C4801MIF-143	143	15.0	22.0	OK	23	153	4	229
Map 8	C4801MIF-144	144	15.0	23.0	OK	20	172	2	223
Map 8	C4801MIF-145	145	15.0	24.0	OK	9	234	6	183
Map 8	C4801MIB-146	146	16.0	2.0	OK	9	177	2	206
Map 8	C4801MIB-147	147	16.0	3.0	OK	32	292	6	235
Map 8	C4801MIB-148	148	16.0	4.0	OK	40	336	7	221
Map 8	C4801MIB-150	150	16.0	5.0	OK	9	408	5	217
Map 8	C4801MIB-151	151	16.0	6.0	OK	9	290	5	257
Map 8	C4801MIB-152	152	16.0	7.0	OK	23	209	2	517
Map 8	C4801MIB-153	153	16.0	8.0	OK	88	192	4	256
Map 8	C4801MIB-154	154	16.0	9.0	OK	62	213	2	255
Map 8	C4801MIB-155	155	16.0	10.0	OK	9	240	2	194
Map 8	C4801MIB-156	156	16.0	11.0	OK	9	263	2	203
Map 8	C4801MIS-157	157	16.0	14.0	OK	78	217	5	164
Map 8	C4801MIS-158	158	16.0	15.0	OK	67	285	5	196
Map 8	C4801MIS-160	160	16.0	16.0	OK	77	265	4	193
Map 8	C4801MIS-161	161	16.0	17.0	OK	42	189	7	149
Map 8	C4801MIS-162	162	16.0	18.0	OK	69	306	6	174
Map 8	C4801MIF-163	163	16.0	19.0	OK	42	292	4	171
Map 8	C4801MIF-164	164	16.0	20.0	OK	68	192	5	146
Map 8	C4801MIF-165	165	16.0	21.0	OK	68	278	6	176
Map 8	C4801MIF-166	166	16.0	22.0	OK	109	207	5	169
Map 8	C4801MIF-167	167	16.0	23.0	OK	9	182	5	145
Map 8	C4801MIF-168	168	16.0	24.0	OK	9	174	4	145

Map Coordinates and Depth Concentration Values for Soils from 8 Residential Properties

Map #	Field ID	CAD ID	Depth	X-Coord	Y-Coord	Concentration (ppm)			
						As	Pb	Cd	Zn
Map 1	C4701THF-012A	F-12	0"-2"	21.0	1.0	10	307	8	226
Map 1	C4701THF-012B	F-12	2"-4"	21.0	1.0	40	206	5	144
Map 1	C4701THF-012C	F-12	4"-6"	21.0	1.0	19	186	7	119
Map 1	C4701THF-012D	F-12	6"-8"	21.0	1.0	57	203	5	118
Map 1	C4701THF-012E	F-12	8"-10"	21.0	1.0	29	189	6	121
Map 1	C4701THF-012F	F-12	10"-12"	21.0	1.0	42	230	7	123
Map 1	C4701THSN-013A	SN-13	0"-2"	10.0	1.0	8	316	6	120
Map 1	C4701THSN-013B	SN-13	2"-4"	10.0	1.0	-8	258	3	104
Map 1	C4701THSN-013C	SN-13	4"-6"	10.0	1.0	25	283	3	85
Map 1	C4701THSN-013D	SN-13	6"-8"	10.0	1.0	0	171	5	94
Map 1	C4701THSN-013E	SN-13	8"-10"	10.0	1.0	29	162	5	91
Map 1	C4701THSN-013F	SN-13	10"-12"	10.0	1.0	7	164	3	95
Map 1	C4710ELB-088A	B-88	0"-2"	0.0	6.0	167	808	11	505
Map 1	C4710ELB-088B	B-88	2"-4"	0.0	6.0	167	721	10	427
Map 1	C4710ELB-088C	B-88	4"-6"	0.0	6.0	211	655	8	392
Map 1	C4710ELB-088D	B-88	6"-8"	0.0	6.0	216	322	6	400
Map 1	C4710ELB-088E	B-88	8"-10"	0.0	6.0	122	462	8	652
Map 1	C4710ELB-088F	B-88	10"-12"	0.0	6.0	104	560	8	652
Map 1	C4711THB-068A	B-68	0"-2"	9.0	4.0	1434	2783	18	482
Map 1	C4711THB-068B	B-68	2"-4"	9.0	4.0	953	1842	13	427
Map 1	C4711THB-068C	B-68	4"-6"	9.0	4.0	653	1345	9	268
Map 1	C4711THB-068D	B-68	6"-8"	9.0	4.0	429	621	5	165
Map 1	C4711THB-068E	B-68	8"-10"	9.0	4.0	194	322	5	108
Map 1	C4711THB-068F	B-68	10"-12"	9.0	4.0	184	264	5	99
Map 1	C4711THB-39A	B-39	0"-2"	8.0	8.0	264	515	9	306
Map 1	C4711THB-39B	B-39	2"-4"	8.0	8.0	302	527	9	269
Map 1	C4711THB-39C	B-39	4"-6"	8.0	8.0	299	558	10	289
Map 1	C4711THB-39D	B-39	6"-8"	8.0	8.0	298	433	9	258
Map 1	C4711THB-39E	B-39	8"-10"	8.0	8.0	177	292	6	156
Map 1	C4711THB-39F	B-39	10"-12"	8.0	8.0	125	258	9	142
Map 1	C4711THF-019A	F-19	0"-2"	22.0	12.0	912	1823	15	455
Map 1	C4711THF-019B	F-19	2"-4"	22.0	12.0	440	2022	14	404
Map 1	C4711THF-019C	F-19	4"-6"	22.0	12.0	316	1135	11	311
Map 1	C4711THF-019D	F-19	6"-8"	22.0	12.0	261	835	7	252
Map 1	C4711THF-019E	F-19	8"-10"	22.0	12.0	207	474	7	181
Map 1	C4711THF-019F	F-19	10"-12"	22.0	12.0	268	487	6	151
Map 1	C4711THF-060A	F-60	0"-2"	21.0	6.0	1222	3924	15	486
Map 1	C4711THF-060B	F-60	2"-4"	21.0	6.0	637	2003	9	325
Map 1	C4711THF-060C	F-60	4"-6"	21.0	6.0	448	1365	8	240
Map 1	C4711THF-060D	F-60	6"-8"	21.0	6.0	322	921	7	171
Map 1	C4711THF-060E	F-60	8"-10"	21.0	6.0	255	709	5	158
Map 1	C4711THF-060F	F-60	10"-12"	21.0	6.0	228	299	4	110
Map 1	C4721HTS-73A	F-73	0"-2"	20.0	15.0	68	447	8	161
Map 1	C4721HTS-73B	F-73	2"-4"	20.0	15.0	70	470	6	147
Map 1	C4721HTS-73C	F-73	4"-6"	20.0	15.0	126	319	5	111
Map 1	C4721HTS-73D	F-73	6"-8"	20.0	15.0	72	338	4	106
Map 1	C4721HTS-73E	F-73	8"-10"	20.0	15.0	78	245	5	97
Map 1	C4721HTS-73F	F-73	10"-12"	20.0	15.0	92	213	6	89
Map 1	C4721THB-105A	B-105	0"-2"	10.0	15.0	122	516	8	173
Map 1	C4721THB-105B	B-105	2"-4"	10.0	15.0	80	333	7	142
Map 1	C4721THB-105C	B-105	4"-6"	10.0	15.0	116	250	7	124
Map 1	C4721THB-105D	B-105	6"-8"	10.0	15.0	124	207	7	105
Map 1	C4721THB-105E	B-105	8"-10"	10.0	15.0	102	199	6	98

Map Coordinates and Depth Concentration Values for Soils from 8 Residential Properties

Map #	Field ID	CAD ID	Depth	X-Coord	Y-Coord	Concentration (ppm)			
						As	Pb	Cd	Zn
Map 1	C4721THB-105F	B-105	10"-12"	10.0	15.0	68	201	5	90
Map 2	C4680CYB-024A	B-24	0"-2"	20.0	0.0	79	492	10	282
Map 2	C4680CYB-024B	B-24	2"-4"	20.0	0.0	112	215	8	178
Map 2	C4680CYB-024C	B-24	4"-6"	20.0	0.0	133	114	5	114
Map 2	C4680CYB-024D	B-24	6"-8"	20.0	0.0	106	99	4	108
Map 2	C4680CYB-024E	B-24	8"-10"	20.0	0.0	32	89	3	98
Map 2	C4680CYB-024F	B-24	10"-12"	20.0	0.0	102	77	4	87
Map 2	C4680CYNS-012A	NS-12	0"-2"	10.0	0.0	82	1115	11	269
Map 2	C4680CYNS-012B	NS-12	2"-4"	10.0	0.0	172	1405	10	190
Map 2	C4680CYNS-012C	NS-12	4"-6"	10.0	0.0	176	675	7	122
Map 2	C4680CYNS-012D	NS-12	6"-8"	10.0	0.0	145	529	8	110
Map 2	C4680CYNS-012E	NS-12	8"-10"	10.0	0.0	151	386	6	139
Map 2	C4680CYNS-012F	NS-12	10"-12"	10.0	0.0	108	283	6	90
Map 2	C4685FIB-063A	B-63	0"-2"	37.0	8.0	424	1572	6	216
Map 2	C4685FIB-063B	B-63	2"-4"	37.0	8.0	304	1345	6	171
Map 2	C4685FIB-063C	B-63	4"-6"	37.0	8.0	166	423	6	125
Map 2	C4685FIB-063D	B-63	6"-8"	37.0	8.0	149	415	6	80
Map 2	C4685FIB-063E	B-63	8"-10"	37.0	8.0	123	392	4	72
Map 2	C4685FIB-063F	B-63	10"-12"	37.0	8.0	148	309	4	63
Map 2	C4690CYB-046A	B-46	0"-2"	17.0	8.0	1394	864	13	216
Map 2	C4690CYB-046B	B-46	2"-4"	17.0	8.0	489	331	6	128
Map 2	C4690CYB-046C	B-46	4"-6"	17.0	8.0	272	150	6	99
Map 2	C4690CYB-046D	B-46	6"-8"	17.0	8.0	255	152	6	93
Map 2	C4690CYB-046E	B-46	8"-10"	17.0	8.0	139	189	3	85
Map 2	C4690CYB-046F	B-46	10"-12"	17.0	8.0	153	56	5	71
Map 2	C4690CYB-083A	B-83	0"-2"	14.0	4.0	2357	3269	23	447
Map 2	C4690CYB-083B	B-83	2"-4"	14.0	4.0	463	412	4	140
Map 2	C4690CYB-083C	B-83	4"-6"	14.0	4.0	334	257	4	109
Map 2	C4690CYB-083D	B-83	6"-8"	14.0	4.0	325	192	3	99
Map 2	C4690CYB-083E	B-83	8"-10"	14.0	4.0	330	393	5	103
Map 2	C4690CYB-083F	B-83	10"-12"	14.0	4.0	339	419	4	111
Map 2	C4690CYF-019A	F-19	0"-2"	4.0	10.0	2486	1861	12	251
Map 2	C4690CYF-019B	F-19	2"-4"	4.0	10.0	2087	1044	12	170
Map 2	C4690CYF-019C	F-19	4"-6"	4.0	10.0	688	373	6	90
Map 2	C4690CYF-019D	F-19	6"-8"	4.0	10.0	607	293	5	87
Map 2	C4690CYF-019E	F-19	8"-10"	4.0	10.0	405	185	5	71
Map 2	C4690CYF-019F	F-19	10"-12"	4.0	10.0	453	173	4	69
Map 2	C4690CYF-061A	F-61	0"-2"	4.0	4.0	2167	1335	12	223
Map 2	C4690CYF-061B	F-61	2"-4"	4.0	4.0	2267	1053	11	197
Map 2	C4690CYF-061C	F-61	4"-6"	4.0	4.0	734	352	6	93
Map 2	C4690CYF-061D	F-61	6"-8"	4.0	4.0	454	229	6	71
Map 2	C4690CYF-061E	F-61	8"-10"	4.0	4.0	191	120	3	61
Map 2	C4690CYF-061F	F-61	10"-12"	4.0	4.0	167	127	5	63
Map 2	C4694CYB-077A	B-77	0"-2"	18.0	15.0	6	148	2	98
Map 2	C4694CYB-077B	B-77	2"-4"	18.0	15.0	21	103	4	84
Map 2	C4694CYB-077C	B-77	4"-6"	18.0	15.0	21	60	3	74
Map 2	C4694CYB-077D	B-77	6"-8"	18.0	15.0	57	60	3	61
Map 2	C4694CYB-077E	B-77	8"-10"	18.0	15.0	10	93	4	111
Map 2	C4694CYB-077F	B-77	10"-12"	18.0	15.0	37	82	3	160
Map 2	C4694CYF-053A	F-53	0"-2"	4.0	14.0	3	250	5	165
Map 2	C4694CYF-053B	F-53	2"-4"	4.0	14.0	5	234	5	152
Map 2	C4694CYF-053C	F-53	4"-6"	4.0	14.0	40	218	5	208
Map 2	C4694CYF-053D	F-53	6"-8"	4.0	14.0	12	185	9	150

Map Coordinates and Depth Concentration Values for Soils from 8 Residential Properties

Map #	Field ID	CAD ID	Depth	X-Coord	Y-Coord	Concentration (ppm)			
						As	Pb	Cd	Zn
Map 2	C4694CYF-053E	F-53	8"-10"	4.0	14.0	16	136	5	135
Map 2	C4694CYF-053F	F-53	10"-12"	4.0	14.0	14	148	5	199
Map 3	C4850ADB-075A	B-75	0"-2"	24.0	5.0	484	299	5	125
Map 3	C4850ADB-075B	B-75	2"-4"	24.0	5.0	184	104	6	88
Map 3	C4850ADB-075C	B-75	4"-6"	24.0	5.0	144	55	4	77
Map 3	C4850ADB-075D	B-75	6"-8"	24.0	5.0	94	32	5	46
Map 3	C4850ADB-075E	B-75	8"-10"	24.0	5.0	149	49	3	50
Map 3	C4850ADB-075F	B-75	10"-12"	24.0	5.0	169	22	4	42
Map 3	C4850ADB-095A	B-95	0"-2"	18.0	3.0	229	158	3	93
Map 3	C4850ADB-095B	B-95	2"-4"	18.0	3.0	251	180	5	108
Map 3	C4850ADB-095C	B-95	4"-6"	18.0	3.0	249	138	4	105
Map 3	C4850ADB-095D	B-95	6"-8"	18.0	3.0	190	103	5	98
Map 3	C4850ADB-095E	B-95	8"-10"	18.0	3.0	118	64	6	81
Map 3	C4850ADB-095F	B-95	10"-12"	18.0	3.0	127	67	6	68
Map 3	C4850ADF-056A	F-56	0"-2"	5.0	5.0	1181	705	17	326
Map 3	C4850ADF-056B	F-56	2"-4"	5.0	5.0	424	259	9	168
Map 3	C4850ADF-056C	F-56	4"-6"	5.0	5.0	286	95	7	92
Map 3	C4850ADF-056D	F-56	6"-8"	5.0	5.0	252	115	4	71
Map 3	C4850ADF-056E	F-56	8"-10"	5.0	5.0	101	77	3	46
Map 3	C4850ADF-056F	F-56	10"-12"	5.0	5.0	39	84	4	41
Map 3	C4850ADF-107A	F-107	0"-2"	6.0	0.0	734	639	12	268
Map 3	C4850ADF-107B	F-107	2"-4"	6.0	0.0	368	386	8	207
Map 3	C4850ADF-107C	F-107	4"-6"	6.0	0.0	343	376	8	208
Map 3	C4850ADF-107D	F-107	6"-8"	6.0	0.0	178	134	4	104
Map 3	C4850ADF-107E	F-107	8"-10"	6.0	0.0	100	35	6	55
Map 3	C4850ADF-107F	F-107	10"-12"	6.0	0.0	94	66	4	52
Map 4	C4771VIB-017A	B-17	0"-2"	4.0	5.0	115	393	7	478
Map 4	C4771VIB-017B	B-17	2"-4"	4.0	5.0	160	450	9	489
Map 4	C4771VIB-017C	B-17	4"-6"	4.0	5.0	231	409	6	621
Map 4	C4771VIB-017D	B-17	6"-8"	4.0	5.0	203	316	5	458
Map 4	C4771VIB-017E	B-17	8"-10"	4.0	5.0	189	266	4	365
Map 4	C4771VIB-017F	B-17	10"-12"	4.0	5.0	144	280	5	228
Map 4	C4771VIF-039A	F-39	0"-2"	22.0	2.0	688	1908	17	404
Map 4	C4771VIF-039B	F-39	2"-4"	22.0	2.0	390	654	12	400
Map 4	C4771VIF-039C	F-39	4"-6"	22.0	2.0	469	564	10	341
Map 4	C4771VIF-039D	F-39	6"-8"	22.0	2.0	427	648	10	309
Map 4	C4771VIF-039E	F-39	8"-10"	22.0	2.0	467	588	10	272
Map 4	C4771VIF-039F	F-39	10"-12"	22.0	2.0	504	568	9	257
Map 5	C200047B-110A	B-110	0"-2"	2.0	5.0	1338	818	13	637
Map 5	C200047B-110B	B-110	2"-4"	2.0	5.0	953	745	15	645
Map 5	C200047B-110C	B-110	4"-6"	2.0	5.0	332	641	10	520
Map 5	C200047B-110D	B-110	6"-8"	2.0	5.0	237	600	11	718
Map 5	C200047B-110E	B-110	8"-10"	2.0	5.0	202	460	7	431
Map 5	C200047B-110F	B-110	10"-12"	2.0	5.0	172	500	6	294
Map 5	C4683VIB-013A	B-13	0"-2"	14.0	0.0	38	15	3	80
Map 5	C4683VIB-013B	B-13	2"-4"	14.0	0.0	15	178	4	244
Map 5	C4683VIB-013C	B-13	4"-6"	14.0	0.0	54	246	6	354
Map 5	C4683VIB-013D	B-13	6"-8"	14.0	0.0	0	295	8	266
Map 5	C4683VIB-013E	B-13	8"-10"	14.0	0.0	24	349	5	278
Map 5	C4683VIB-013F	B-13	10"-12"	14.0	0.0	24	381	4	274
Map 5	C4683VIF-014A	F-14	0"-2"	28.0	0.0	68	445	7	683
Map 5	C4683VIF-014B	F-14	2"-4"	28.0	0.0	139	536	9	683
Map 5	C4683VIF-014C	F-14	4"-6"	28.0	0.0	43	480	9	1121

Map Coordinates and Depth Concentration Values for Soils from 8 Residential Properties

Map #	Field ID	CAD ID	Depth	X-Coord	Y-Coord	Concentration (ppm)			
						As	Pb	Cd	Zn
Map 5	C4683VIF-014D	F-14	6"-8"	28.0	0.0	1115	1889	14	610
Map 5	C4683VIF-014E	F-14	8"-10"	28.0	0.0	165	574	6	664
Map 5	C4683VIF-014F	F-14	10"-12"	28.0	0.0	116	451	6	606
Map 5	C4691VIB-031A	B-31	0"-2"	12.0	11.0	2769	1832	15	621
Map 5	C4691VIB-031B	B-31	2"-4"	12.0	11.0	2704	2625	20	594
Map 5	C4691VIB-031C	B-31	4"-6"	12.0	11.0	1484	1316	12	575
Map 5	C4691VIB-031D	B-31	6"-8"	12.0	11.0	1373	957	8	497
Map 5	C4691VIB-031E	B-31	8"-10"	12.0	11.0	785	513	7	447
Map 5	C4691VIB-031F	B-31	10"-12"	12.0	11.0	658	346	5	361
Map 5	C4691VIB-068A	B-68	0"-2"	14.0	6.0	922	1669	13	447
Map 5	C4691VIB-068B	B-68	2"-4"	14.0	6.0	1049	1562	14	447
Map 5	C4691VIB-068C	B-68	4"-6"	14.0	6.0	403	523	7	365
Map 5	C4691VIB-068D	B-68	6"-8"	14.0	6.0	362	408	6	350
Map 5	C4691VIB-068E	B-68	8"-10"	14.0	6.0	351	352	7	323
Map 5	C4691VIB-068F	B-68	10"-12"	14.0	6.0	255	291	5	287
Map 5	C4691VIF-002A	F-2	0"-2"	28.0	9.7	3311	2400	30	1439
Map 5	C4691VIF-002B	F-2	2"-4"	28.0	9.7	917	565	13	811
Map 5	C4691VIF-002C	F-2	4"-6"	28.0	9.7	688	366	8	396
Map 5	C4691VIF-002D	F-2	6"-8"	28.0	9.7	683	410	6	349
Map 5	C4691VIF-002E	F-2	8"-10"	28.0	9.7	622	340	5	458
Map 5	C4691VIF-002F	F-2	10"-12"	28.0	9.7	765	473	6	354
Map 6	C5040STC-001	FC-1	0"-2"	9.5	2.5	57	207	6	107
Map 6	C5040STC-001	FC-1	2"-4"	9.5	2.5	103	153	4	97
Map 6	C5040STC-001	FC-1	4"-6"	9.5	2.5	82	154	5	97
Map 6	C5040STC-001	FC-1	6"-8"	9.5	2.5	58	102	3	84
Map 6	C5040STC-001	FC-1	8"-10"	9.5	2.5	46	94	4	69
Map 6	C5040STC-001	FC-1	10"-12"	9.5	2.5	68	100	2	58
Map 6	C5040STC-002	FC-2	0"-2"	7.5	18.5	108	189	4	86
Map 6	C5040STC-002	FC-2	2"-4"	7.5	18.5	112	114	4	62
Map 6	C5040STC-002	FC-2	4"-6"	7.5	18.5	91	73	4	50
Map 6	C5040STC-002	FC-2	6"-8"	7.5	18.5	95	71	5	59
Map 6	C5040STC-002	FC-2	8"-10"	7.5	18.5	125	84	4	53
Map 6	C5040STC-002	FC-2	10"-12"	7.5	18.5	83	139	4	75
Map 7	C4712JOC-1	FC-1	0"-2"	11.0	11.5	123	438	8	827
Map 7	C4712JOC-1	FC-1	2"-4"	11.0	11.5	154	468	7	1502
Map 7	C4712JOC-1	FC-1	4"-6"	11.0	11.5	164	450	9	1571
Map 7	C4712JOC-1	FC-1	6"-8"	11.0	11.5	151	468	8	1416
Map 7	C4712JOC-1	FC-1	8"-10"	11.0	11.5	109	428	8	1261
Map 7	C4712JOC-1	FC-1	10"-12"	11.0	11.5	51	212	4	610
Map 7	C4712JOC-2	FC-2	0"-2"	14.5	1.0	9	181	6	245
Map 7	C4712JOC-2	FC-2	2"-4"	14.5	1.0	35	211	7	261
Map 7	C4712JOC-2	FC-2	4"-6"	14.5	1.0	40	211	5	261
Map 7	C4712JOC-2	FC-2	6"-8"	14.5	1.0	23	199	4	237
Map 7	C4712JOC-2	FC-2	8"-10"	14.5	1.0	41	213	6	238
Map 7	C4712JOC-2	FC-2	10"-12"	14.5	1.0	-16	250	7	243
Map 8	C4809MIB-C2	BC-2	0"-2"	6.5	13.0	191	192	9	142
Map 8	C4809MIB-C2	BC-2	2"-4"	6.5	13.0	138	204	6	135
Map 8	C4809MIB-C2	BC-2	4"-6"	6.5	13.0	158	207	7	124
Map 8	C4809MIB-C2	BC-2	6"-8"	6.5	13.0	81	191	6	112
Map 8	C4809MIB-C2	BC-2	8"-10"	6.5	13.0	75	173	6	102
Map 8	C4809MIB-C2	BC-2	10"-12"	6.5	13.0	104	139	6	94
Map 8	C4809MIF-C1	BC-1	0"-2"	6.5	24.0	499	225	7	135
Map 8	C4809MIF-C1	BC-1	2"-4"	6.5	24.0	410	195	6	120

Map Coordinates and Depth Concentration Values for Soils from 8 Residential Properties

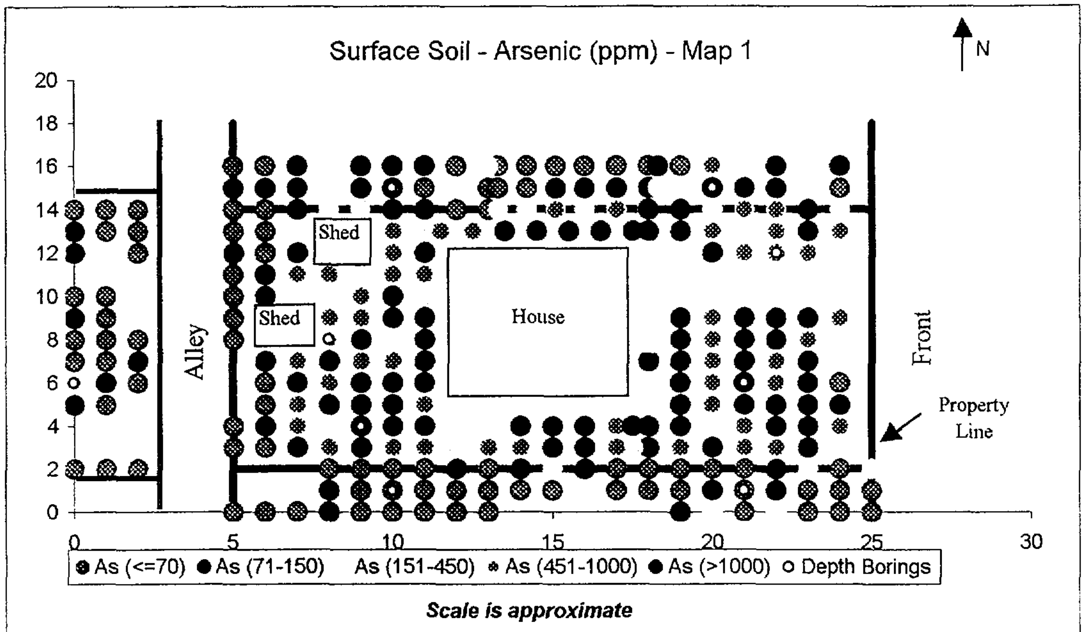
Map #	Field ID	CAD ID	Depth	X-Coord	Y-Coord	Concentration (ppm)			
						As	Pb	Cd	Zn
Map 8	C4809MIF-C1	BC-1	4"-6"	6.5	24.0	451	199	6	130
Map 8	C4809MIF-C1	BC-1	6"-8"	6.5	24.0	244	164	6	96
Map 8	C4809MIF-C1	BC-1	8"-10"	6.5	24.0	182	98	6	68
Map 8	C4809MIF-C1	BC-1	10"-12"	6.5	24.0	151	99	4	78

APPENDIX E

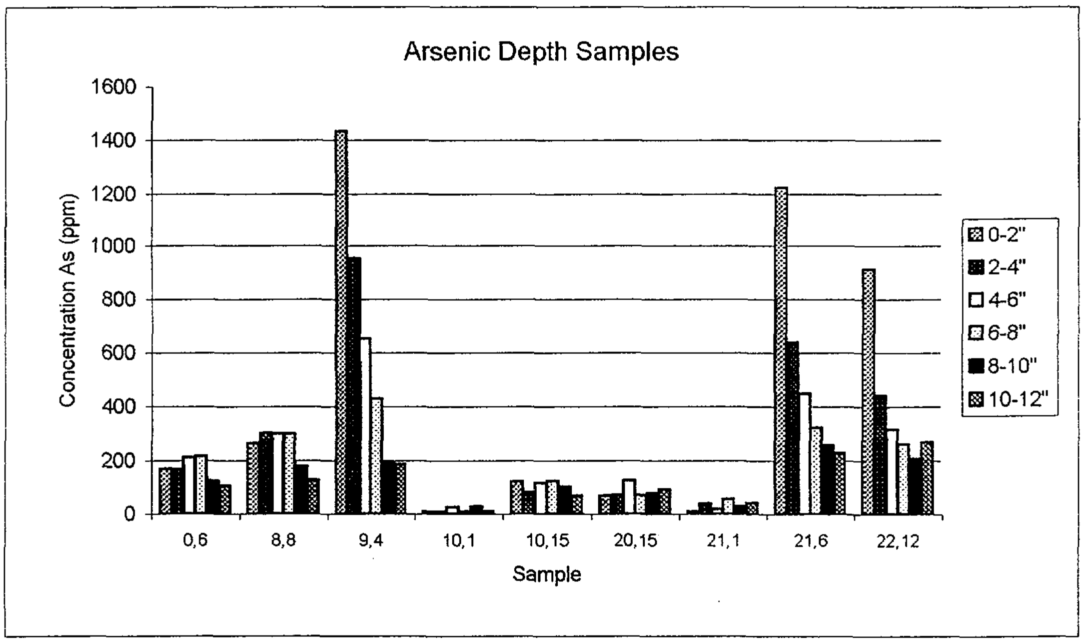
Risk Based Sampling 2-D Schematics

APPENDIX E1
Surface Soil and Depth Profile for Arsenic

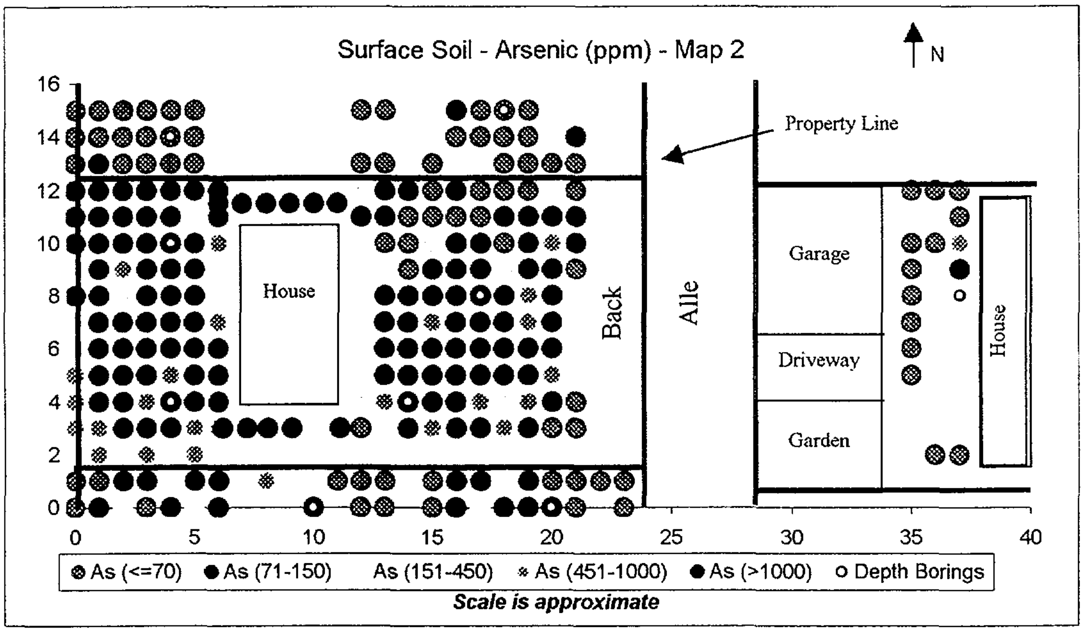
Surface Soil and Depth Profile for Arsenic
Location 1



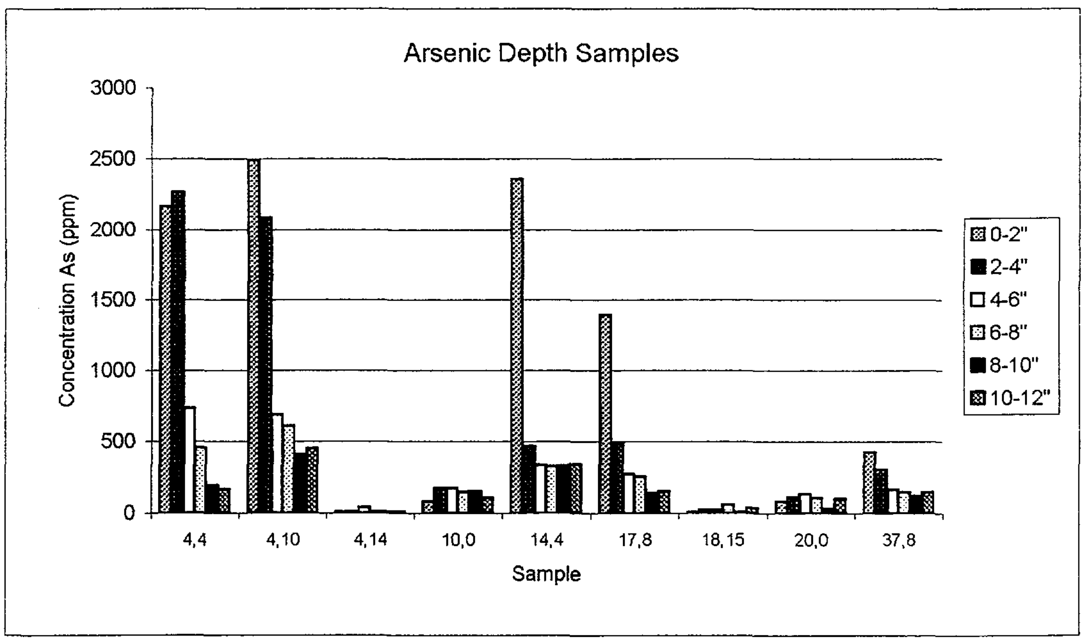
Summary Statistics	N=152
Mean= 970 ppm	Min= 9 ppm
SD= 787 ppm	Max= 4514 ppm



Surface Soil and Depth Profile for Arsenic
Location 2

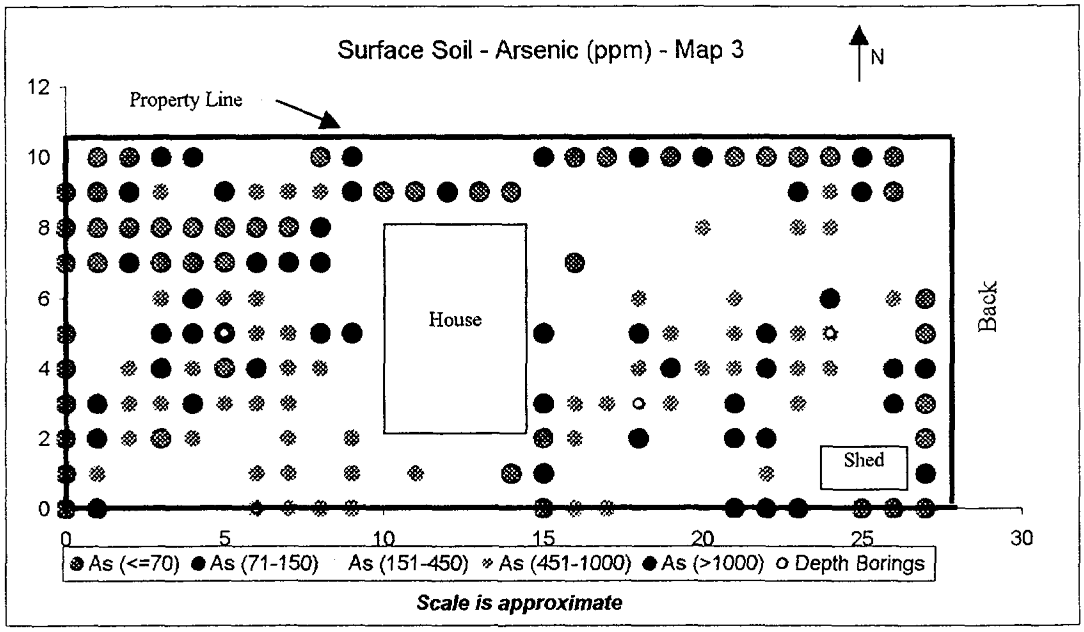


Summary Statistics	N=177
Mean= 1889 ppm	Min= 9 ppm
SD= 2034 ppm	Max= 11785 ppm

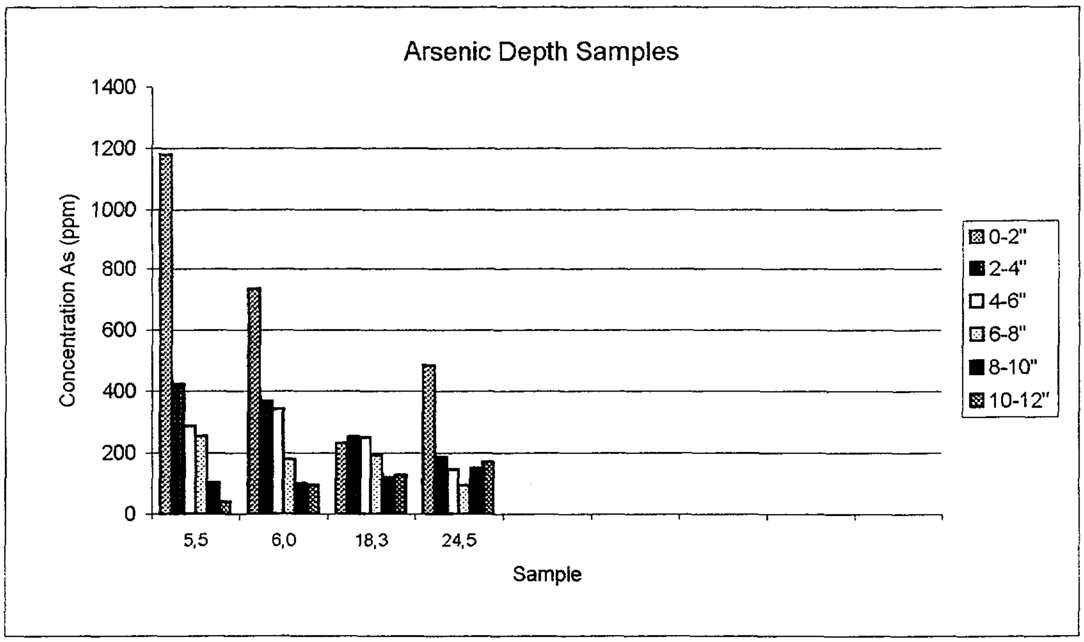


app. E1&E2 As&Pb.xls

Surface Soil and Depth Profile for Arsenic
Location 3

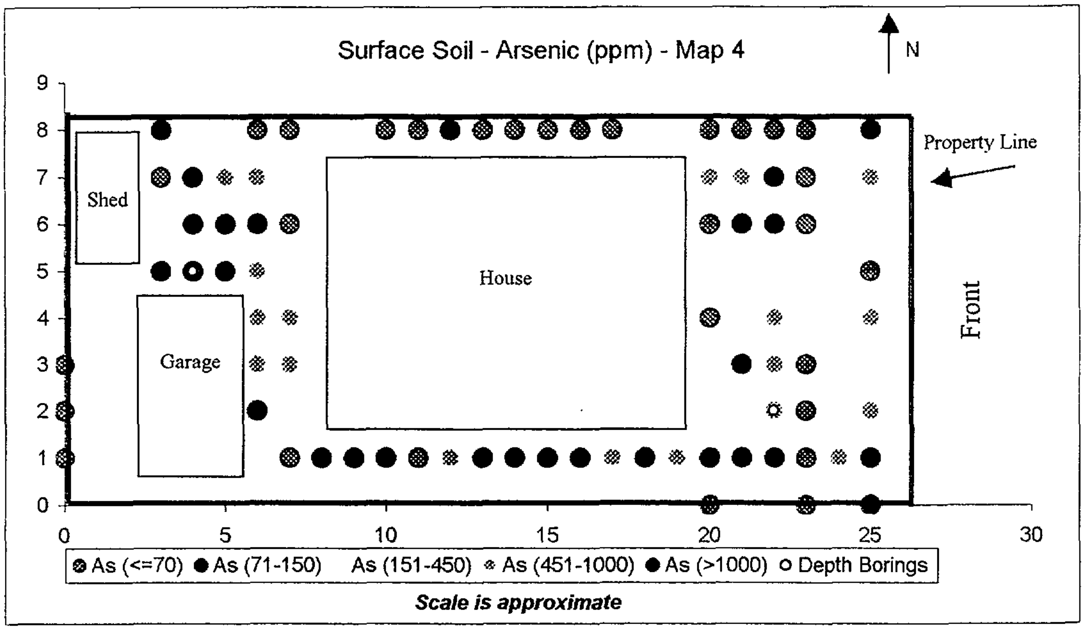


Summary Statistics	N=228
Mean= 382 ppm	Min= 9 ppm
SD= 404 ppm	Max= 2729 ppm

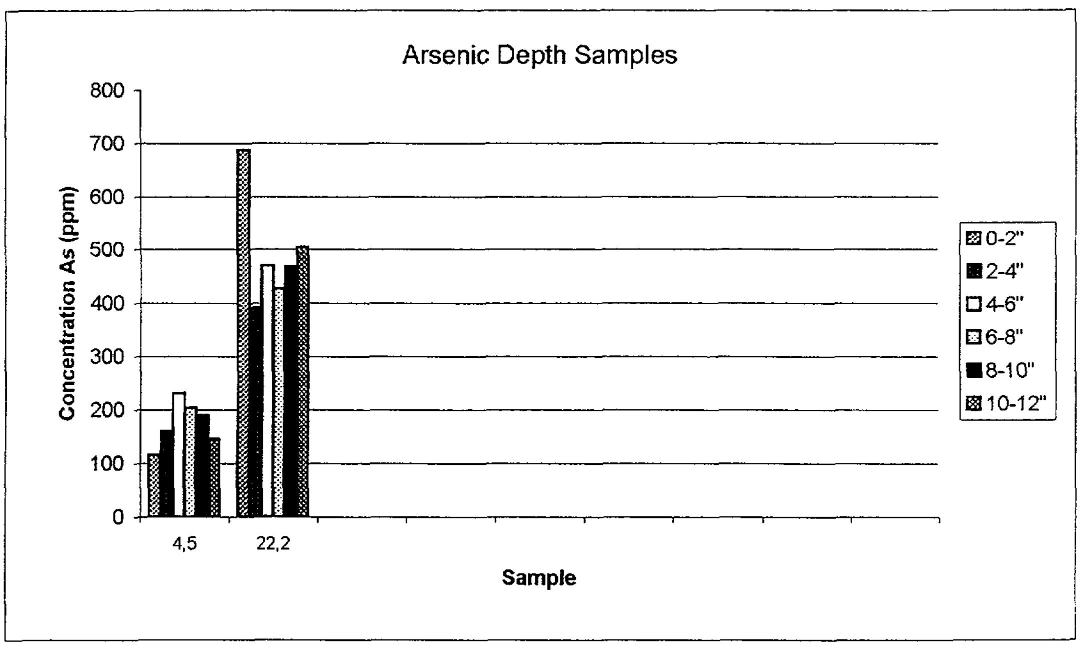


app. E1&E2 As&Pb.xls

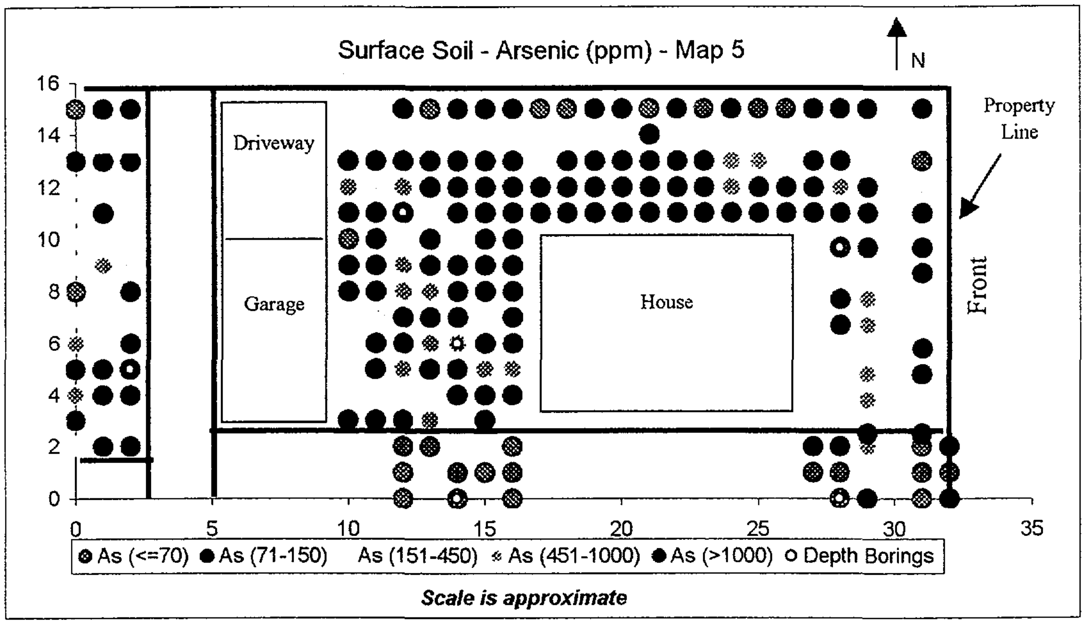
Surface Soil and Depth Profile for Arsenic
Location 4



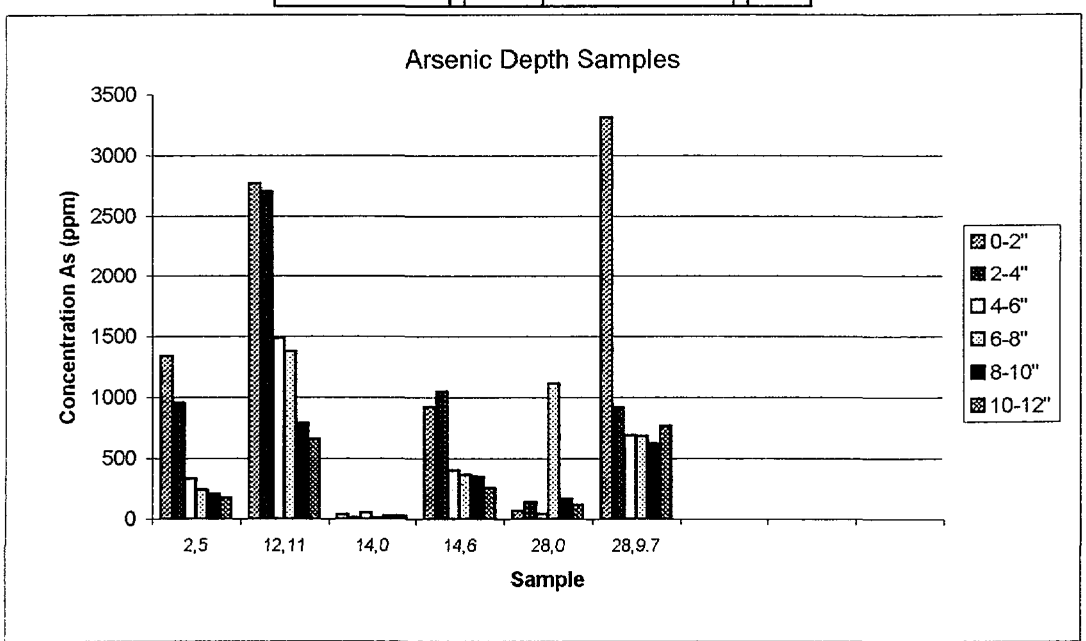
Summary Statistics	N=89
Mean= 511 ppm	Min= 9 ppm
SD= 577 ppm	Max= 2536 ppm



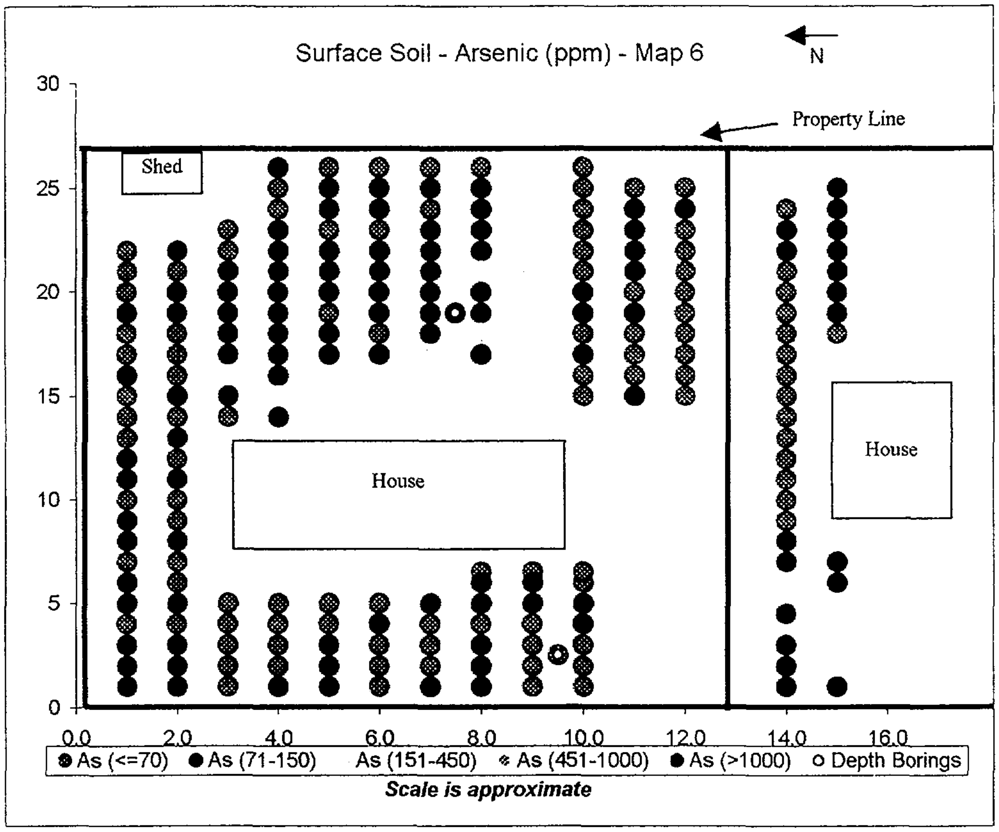
Surface Soil and Depth Profile for Arsenic
Location 5



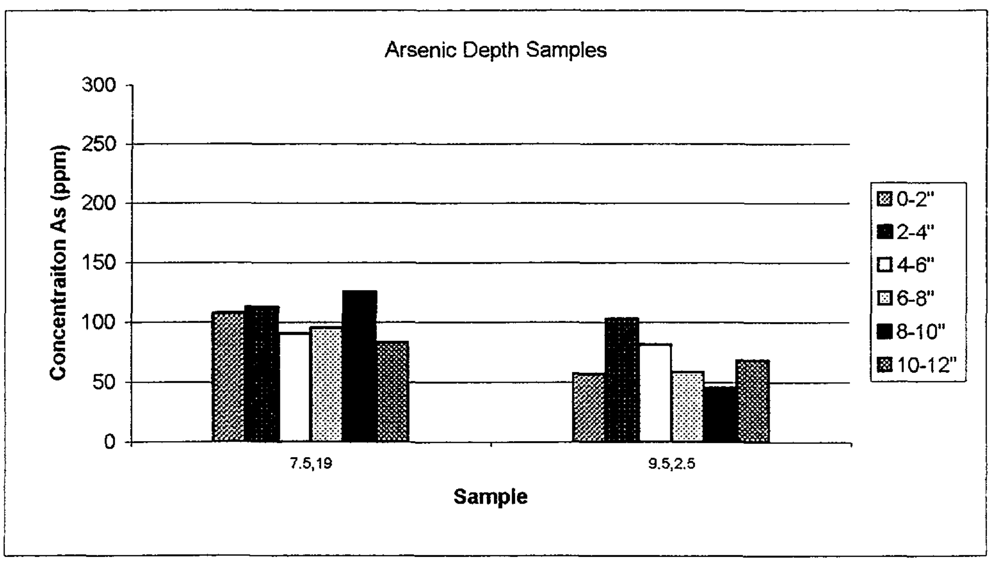
Summary Statistics	N=142
Mean= 2365 ppm	Min= 28 ppm
SD= 2701 ppm	Max= 16176 ppm



Surface Soil and Depth Profile for Arsenic
Location 6

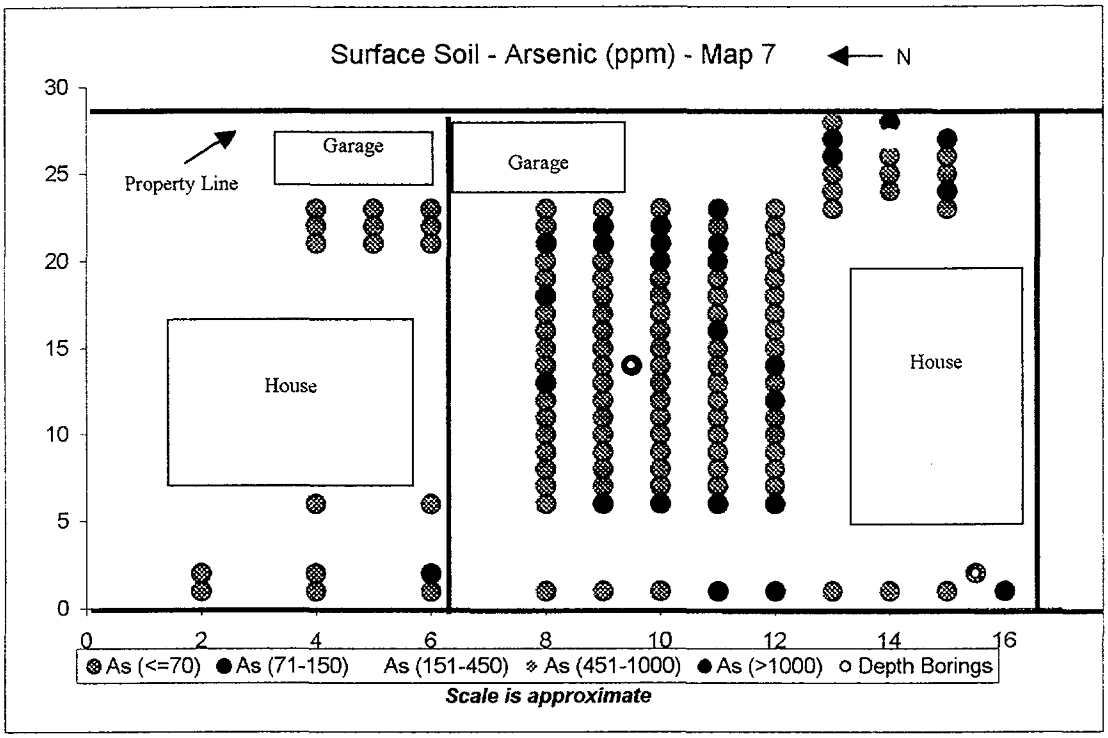


Summary Statistics	N=189
Mean= 74 ppm	Min= 9 ppm
SD= 40 ppm	Max= 231 ppm

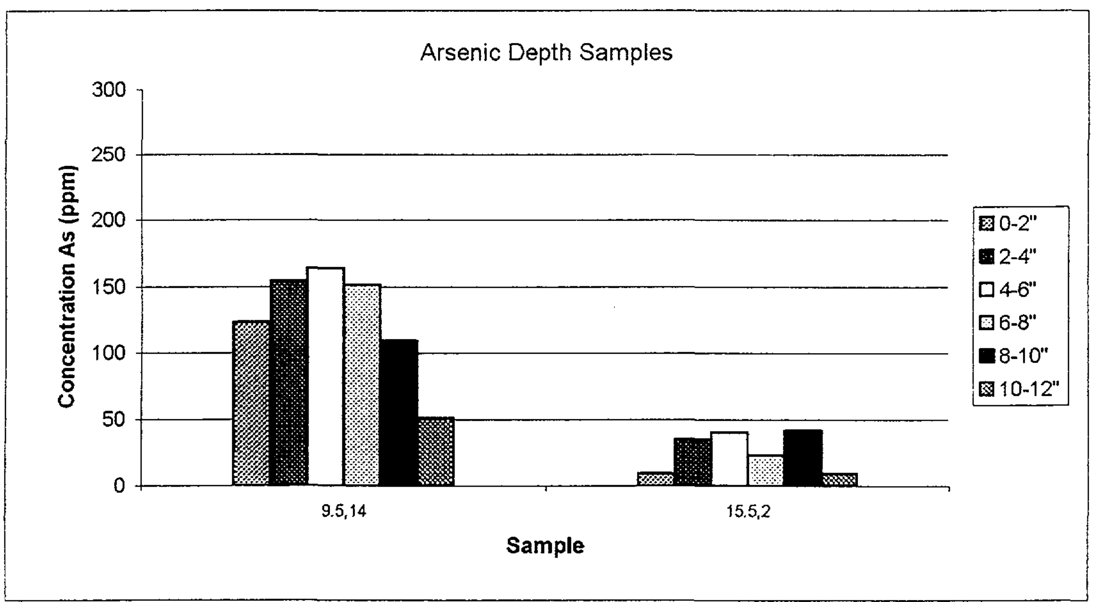


E1-6

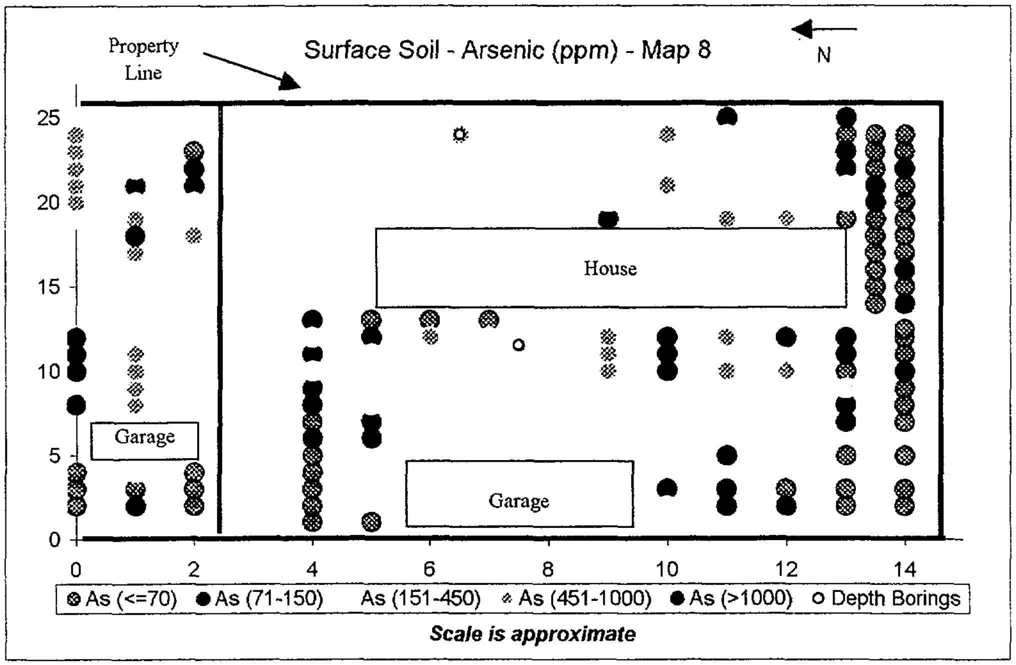
Surface Soil and Depth Profile for Arsenic
Location 7



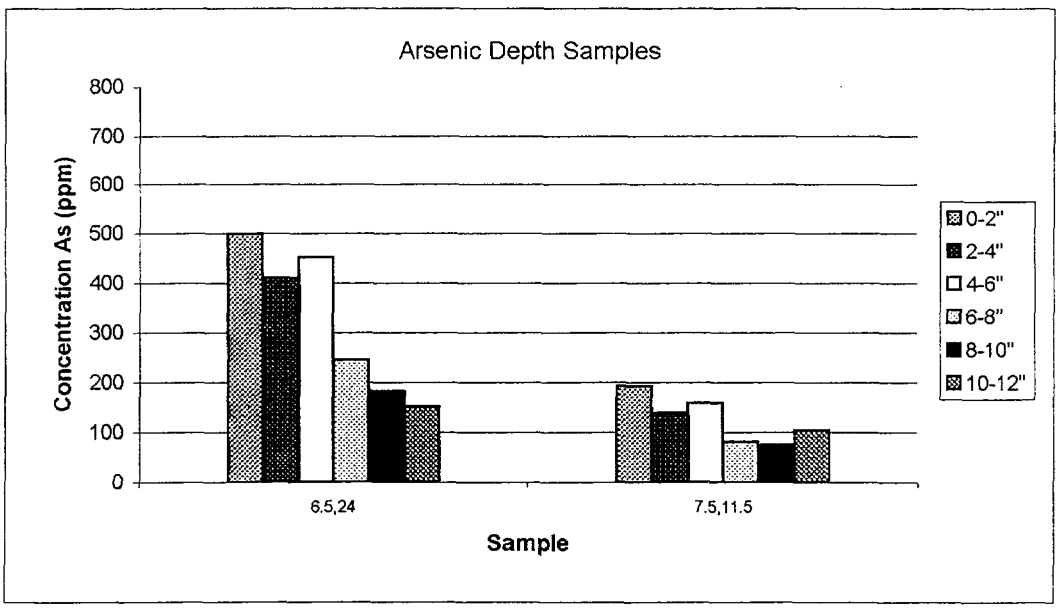
Summary Statistics	N=117
Mean= 48 ppm	Min= 9 ppm
SD= 37 ppm	Max= 164 ppm



Surface Soil and Depth Profile for Arsenic
Location 8

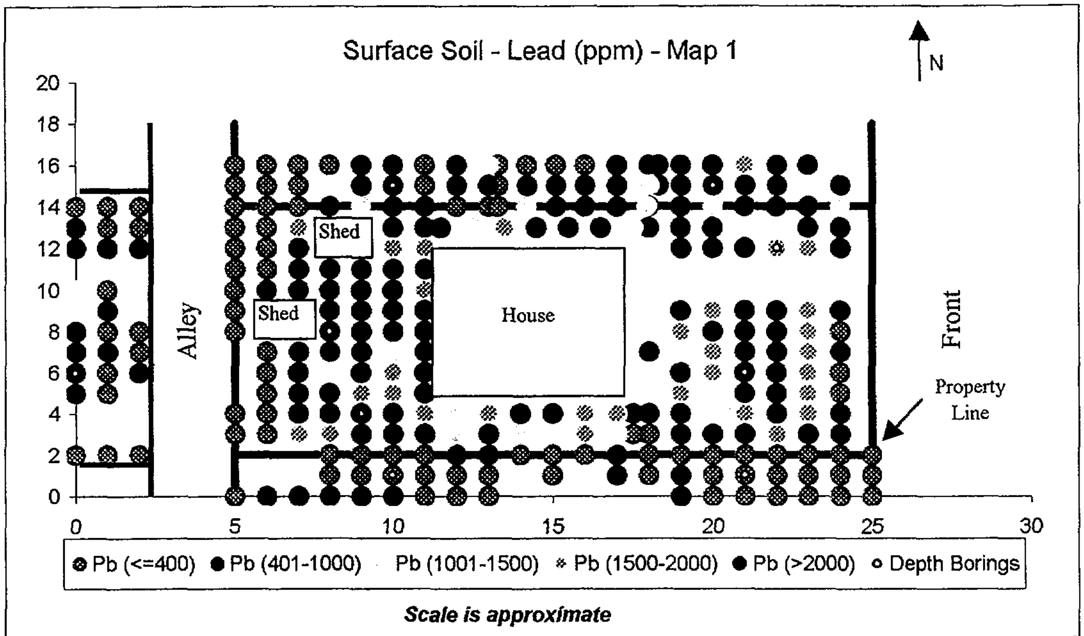


Summary Statistics	N=166
Mean= 232 ppm	Min= 9 ppm
SD= 243 ppm	Max= 1716 ppm

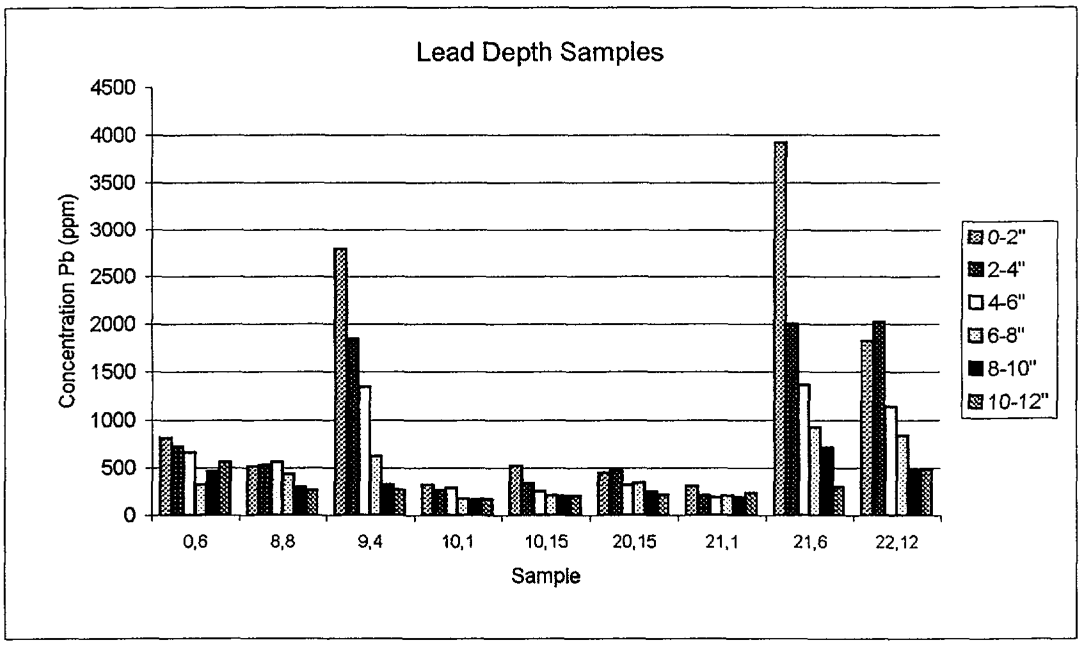


APPENDIX E2
Surface Soil and Depth Profile for Lead

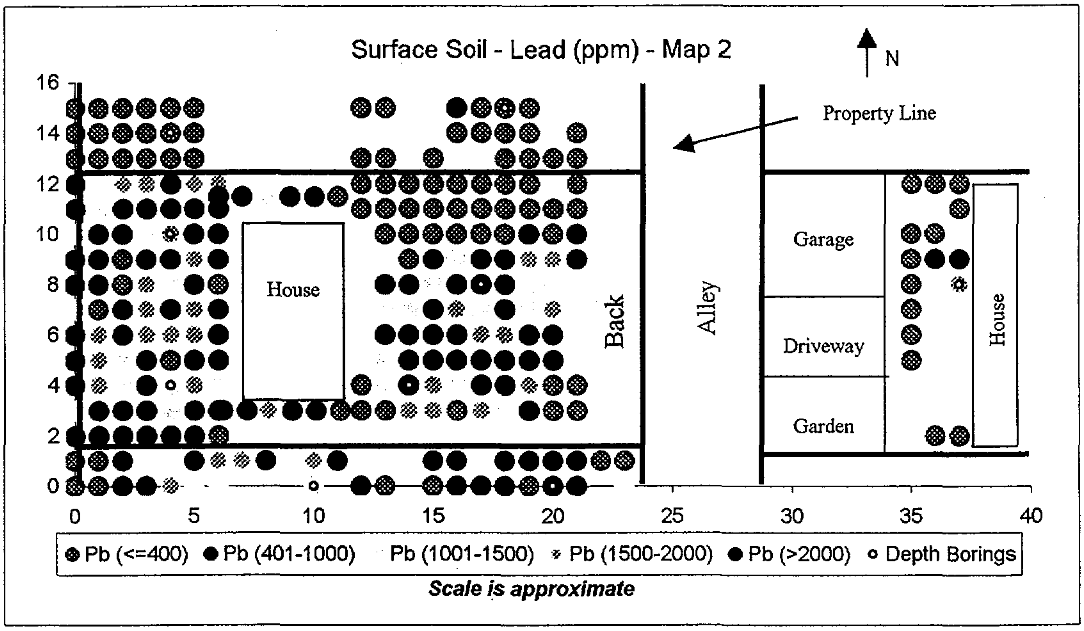
Surface Soil and Depth Profile for Lead
Location 1



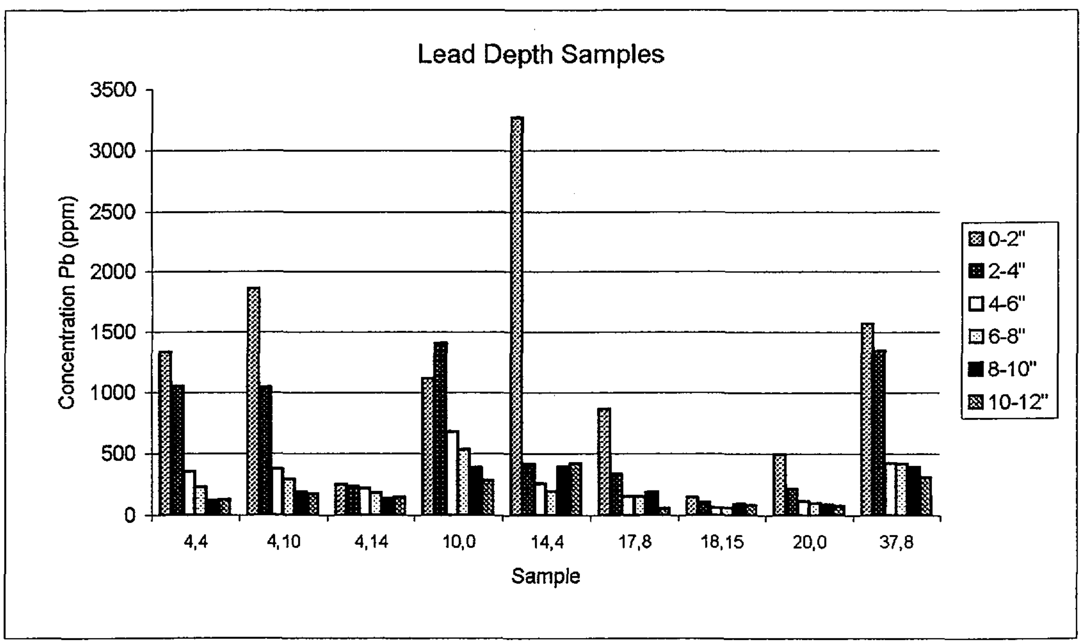
Summary Statistics	N=152
Mean= 1602 ppm	Min= 212 ppm
SD= 1044 ppm	Max= 4829 ppm



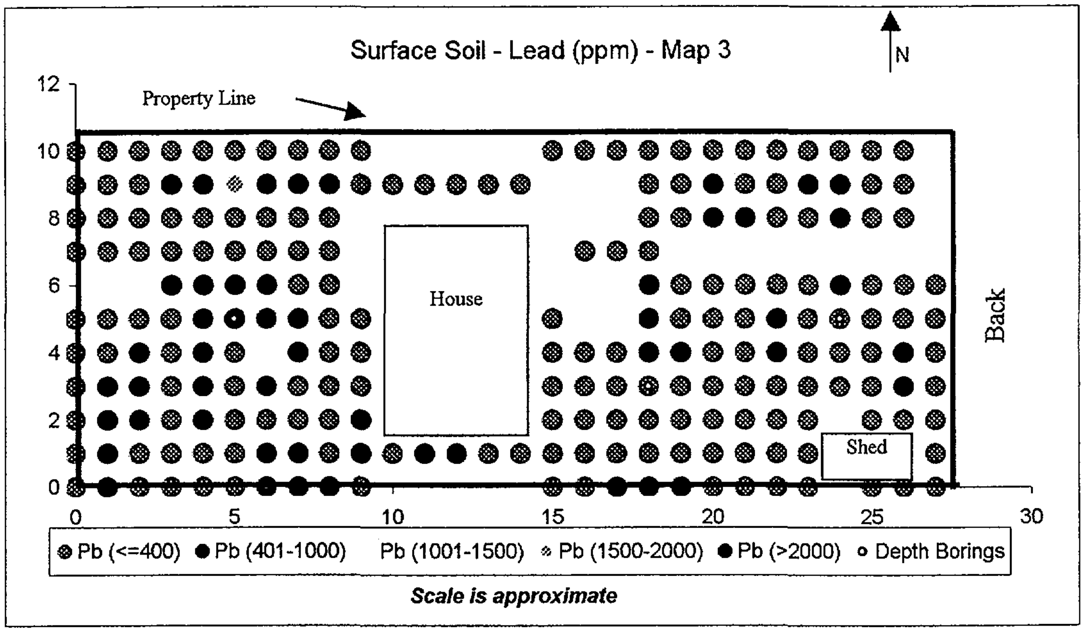
Surface Soil and Depth Profile for Lead
Location 2



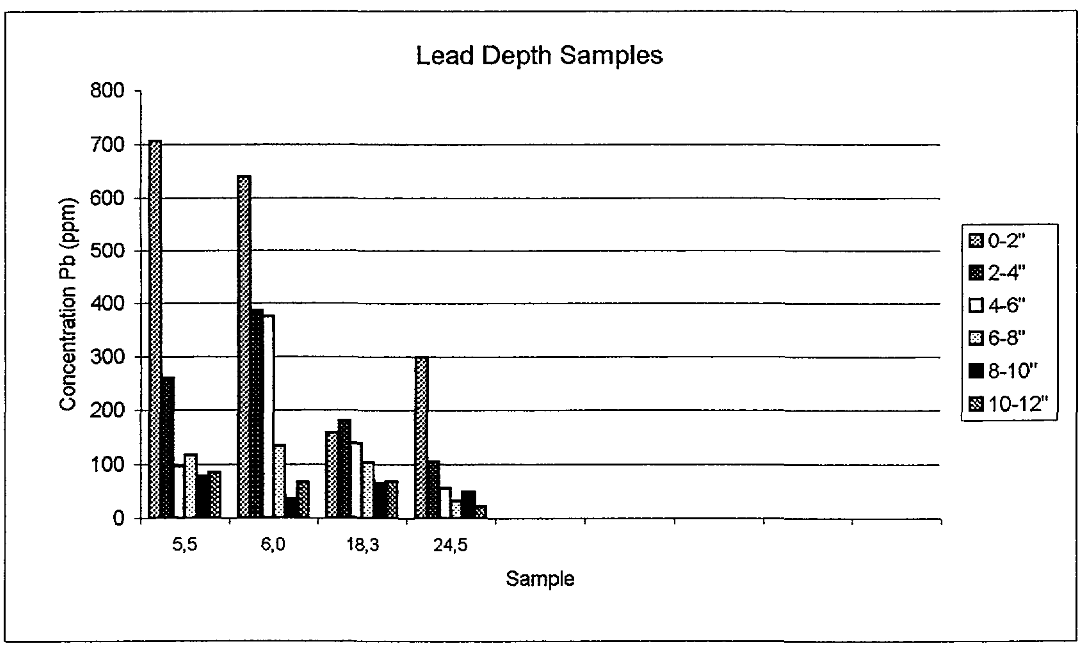
Summary Statistics	N=177
Mean= 1258 ppm	Min= 65 ppm
SD= 942 ppm	Max= 4889 ppm



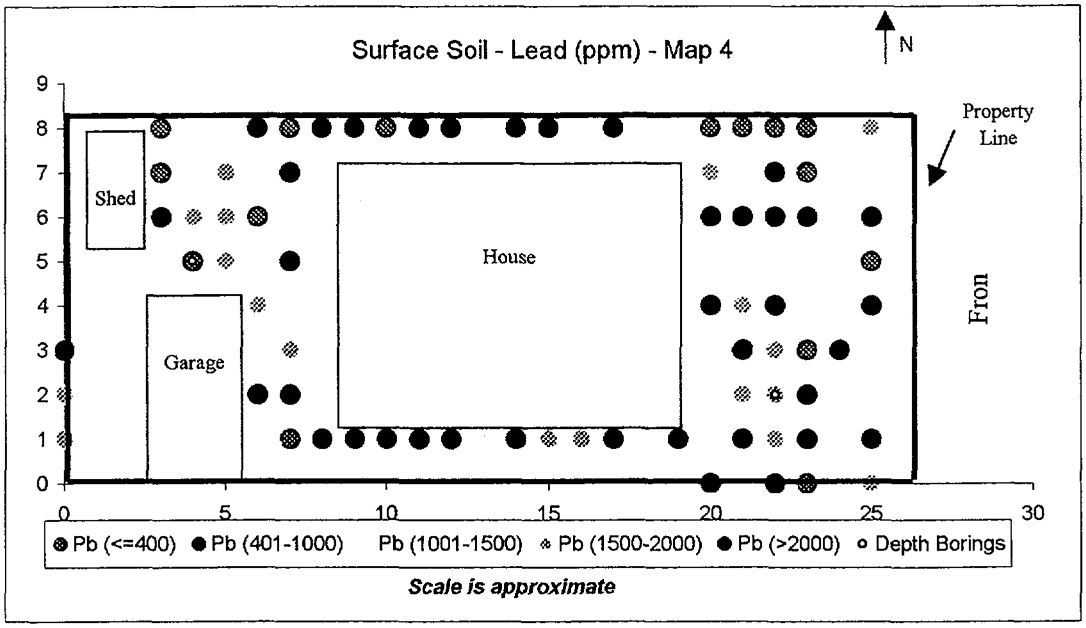
Surface Soil and Depth Profile for Lead
Location 3



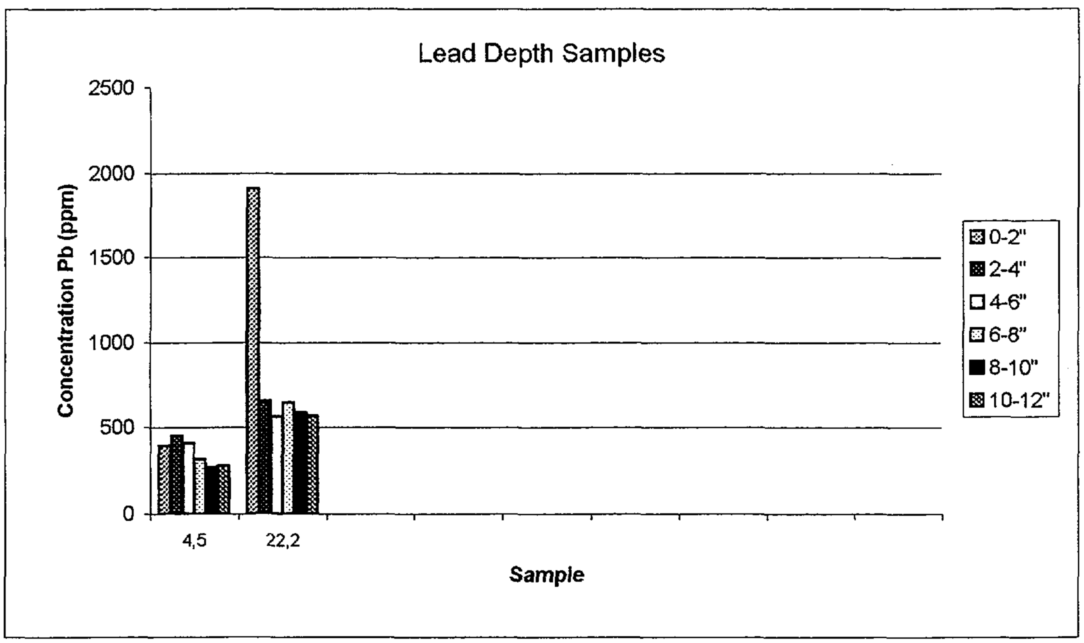
Summary Statistics	N=228
Mean= 294 ppm	Min= 22 ppm
SD= 216 ppm	Max= 1542 ppm



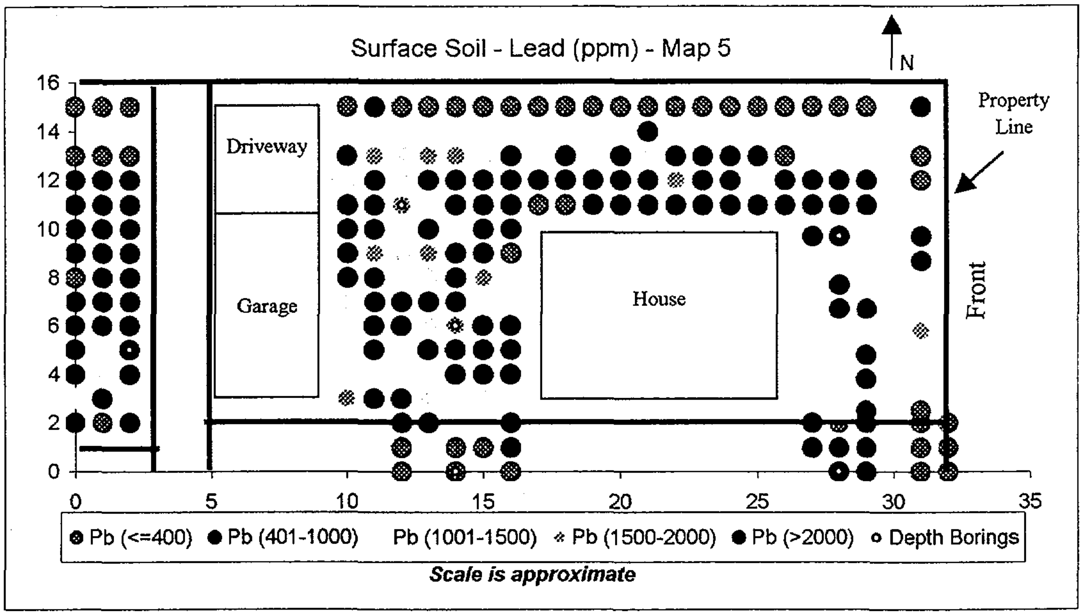
Surface Soil and Depth Profile for Lead
Location 4



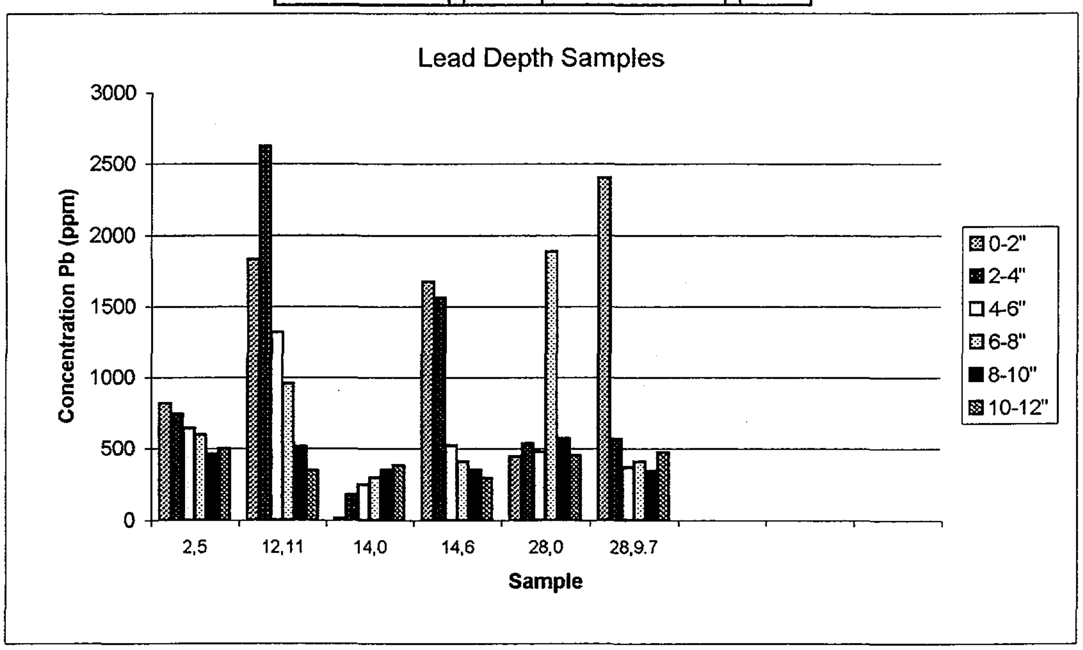
Summary Statistics	N=89
Mean= 1051 ppm	Min= 93 ppm
SD= 674 ppm	Max= 3127 ppm



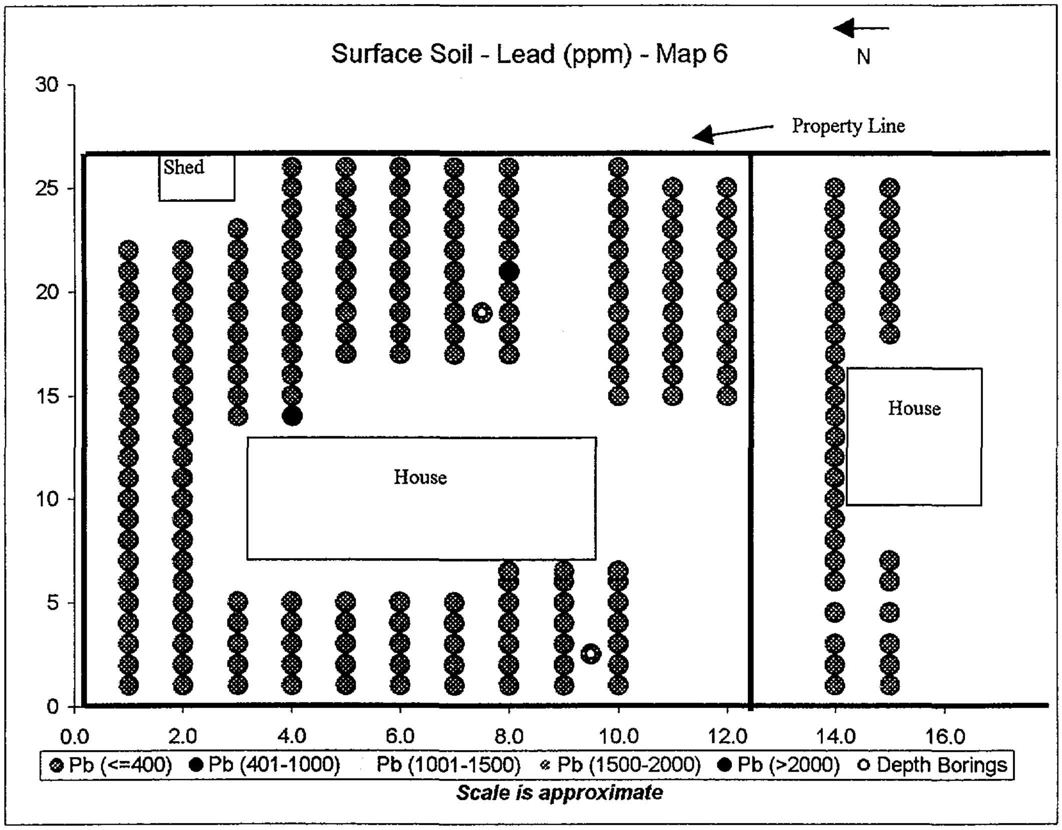
Surface Soil and Depth Profile for Lead
Location 5



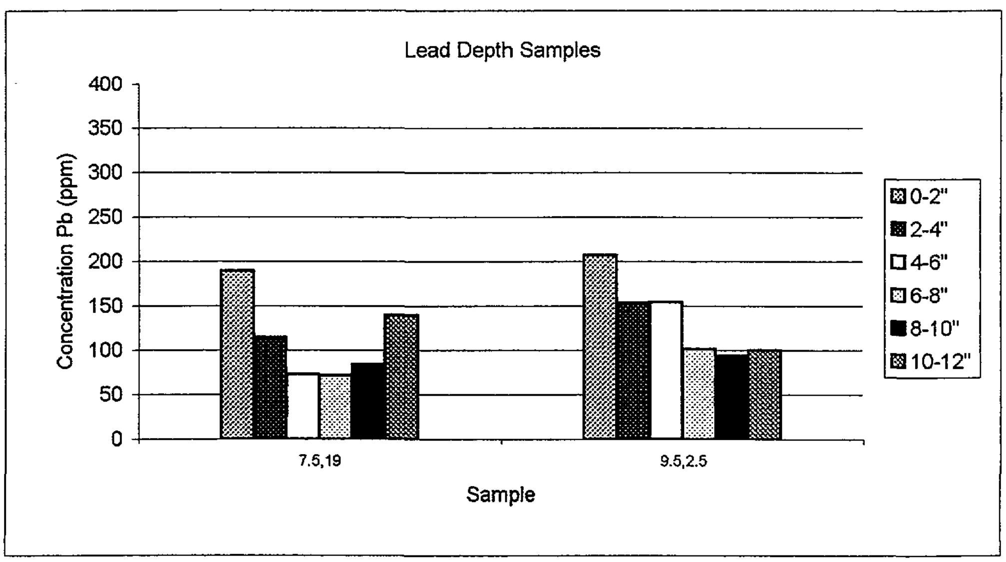
Summary Statistics	N=142
Mean= 1671 ppm	Min= 65 ppm
SD= 1182 ppm	Max= 5072 ppm



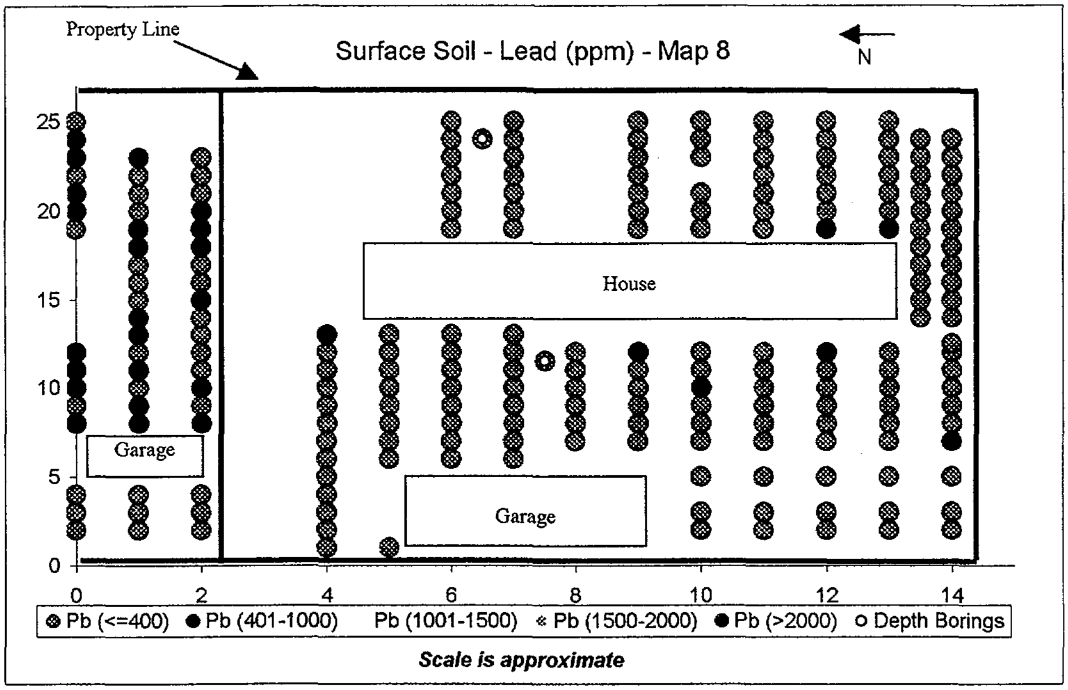
Appendix E-2 Surface Soil and Depth Profile for Lead
Location 6



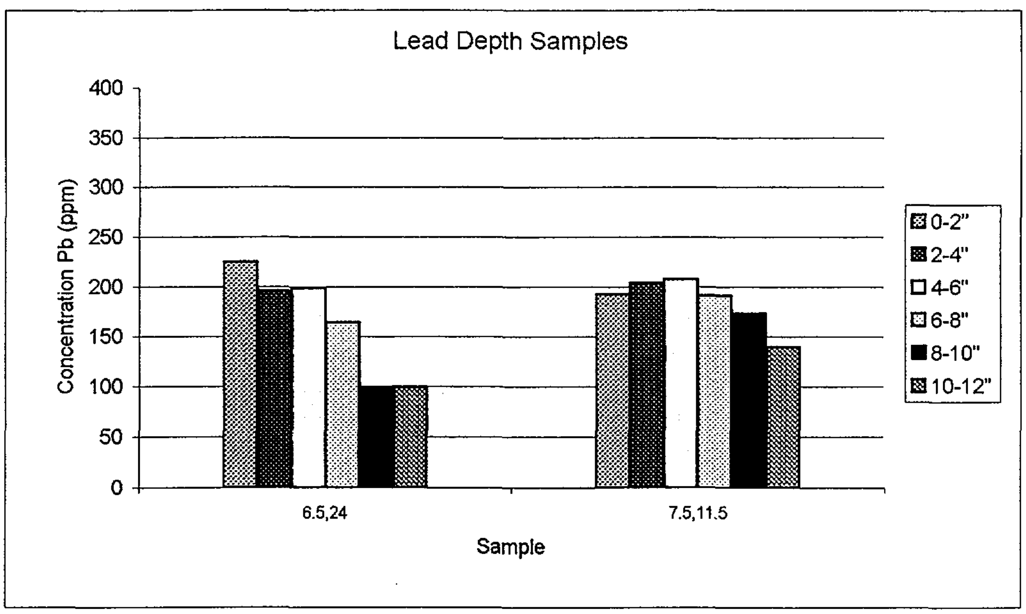
Summary Statistics	N=189
Mean= 134 ppm	Min= 51 ppm
SD= 61 ppm	Max= 469 ppm



Surface Soil and Depth Profile for Lead
Location 8



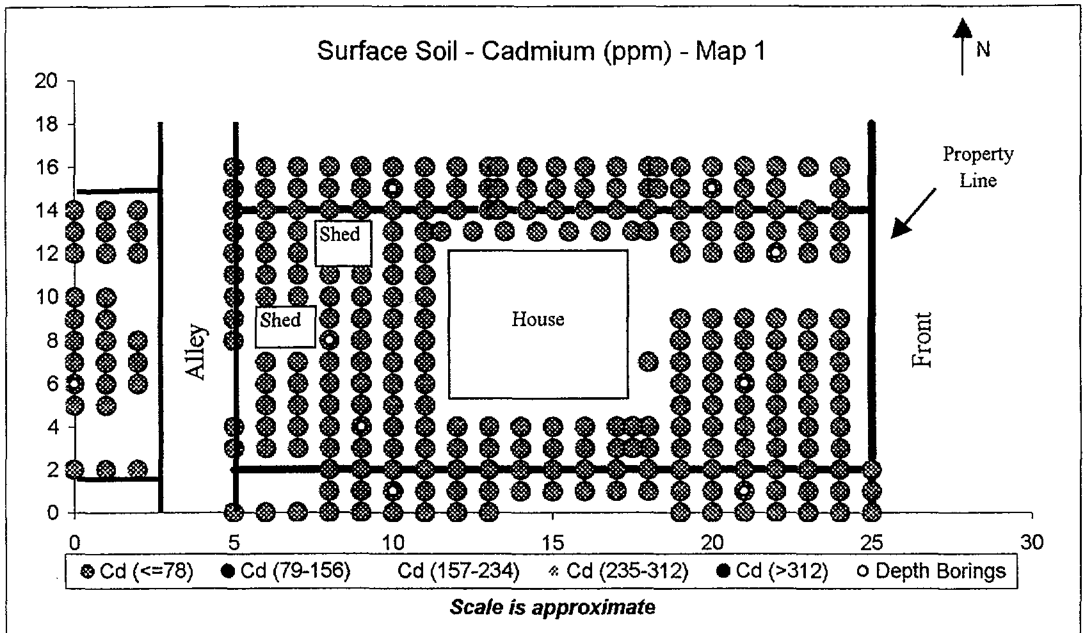
Summary Statistics	N=166
Mean= 220 ppm	Min= 50 ppm
SD= 80 ppm	Max= 635 ppm



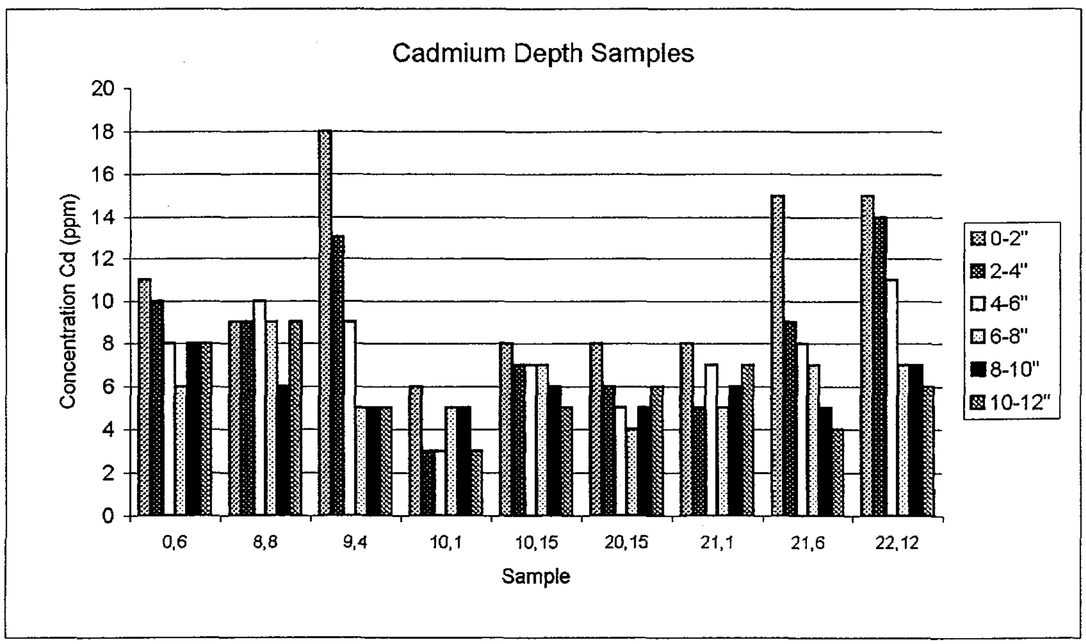
APPENDIX E3

Surface Soil and Depth Profile for Cadmium

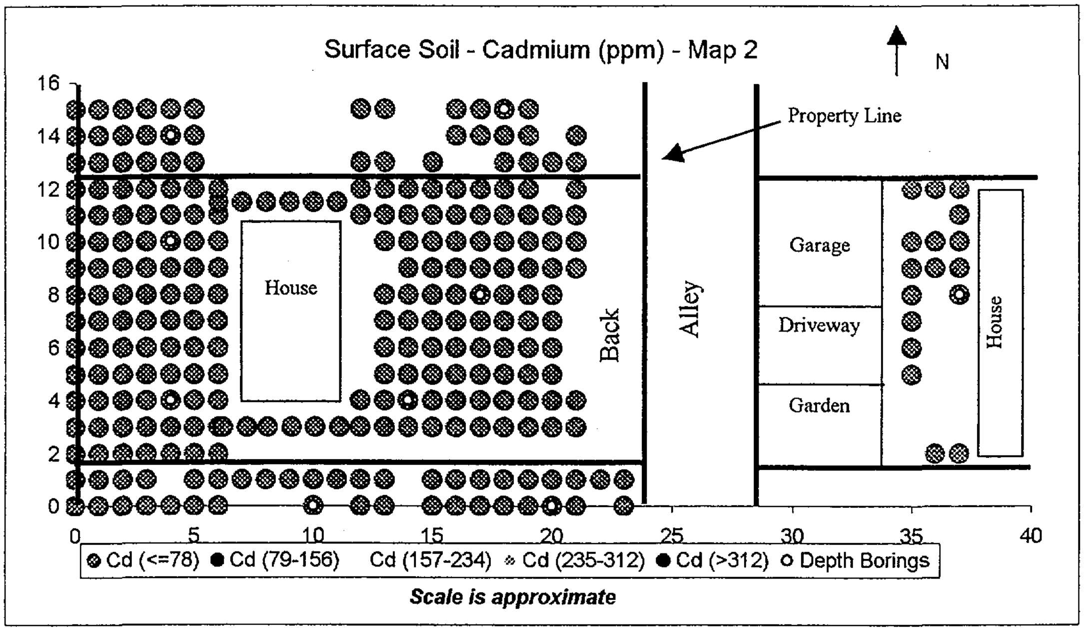
Surface Soil and Depth Profile for Cadmium
Location 1



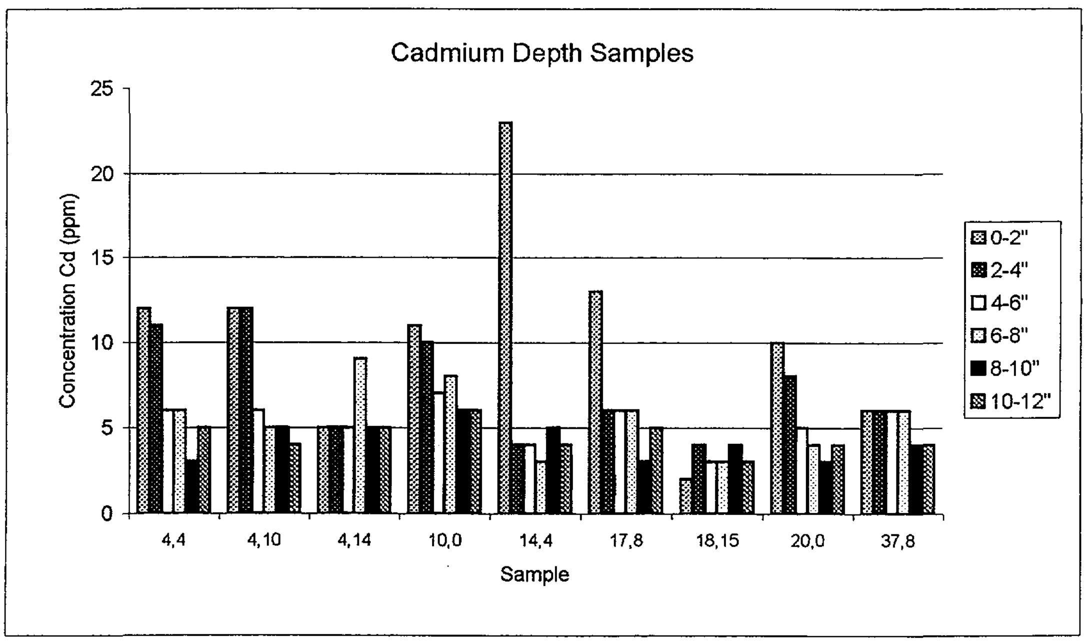
Summary Statistics	N=152
Mean= 12 ppm	Min= 2 ppm
SD= 5 ppm	Max= 28 ppm



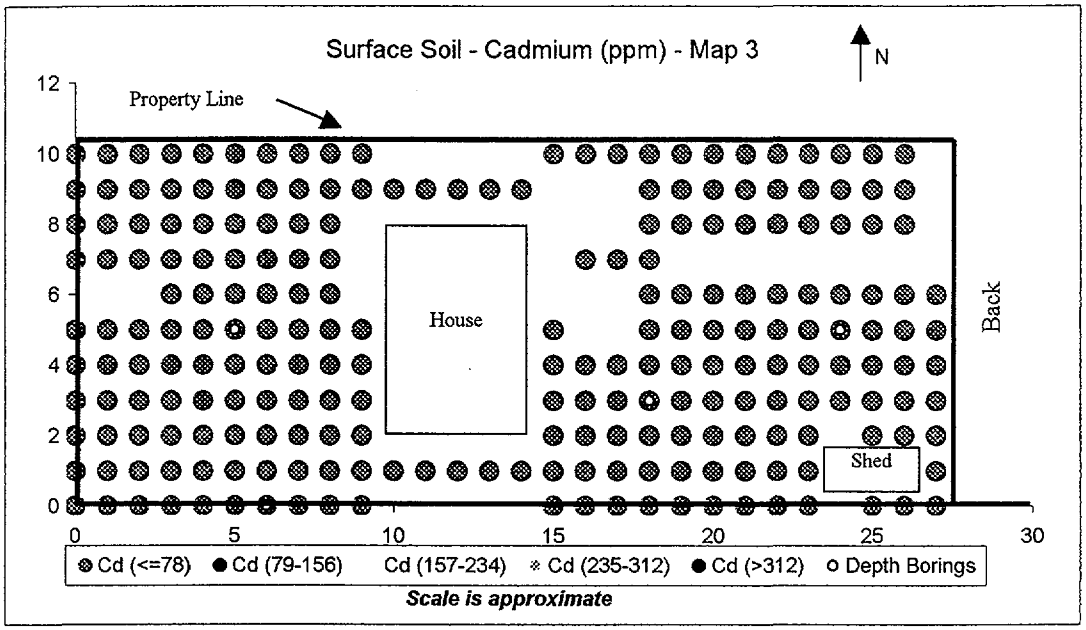
Surface Soil and Depth Profile for Cadmium
Location 2



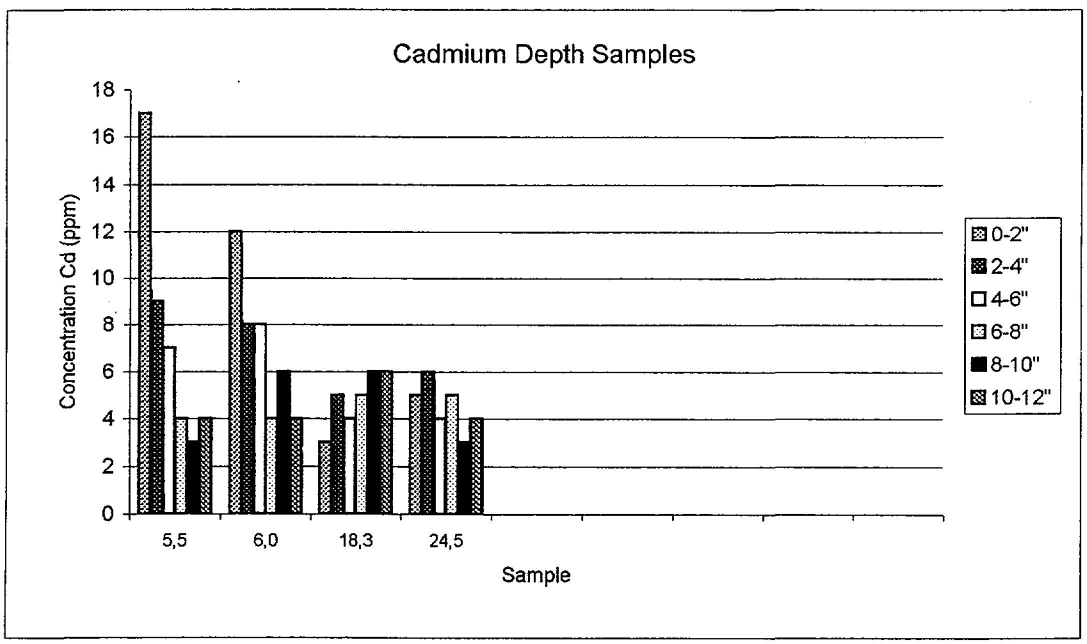
Summary Statistics	N=177
Mean= 11 ppm	Min= 2 ppm
SD= 5 ppm	Max= 24 ppm



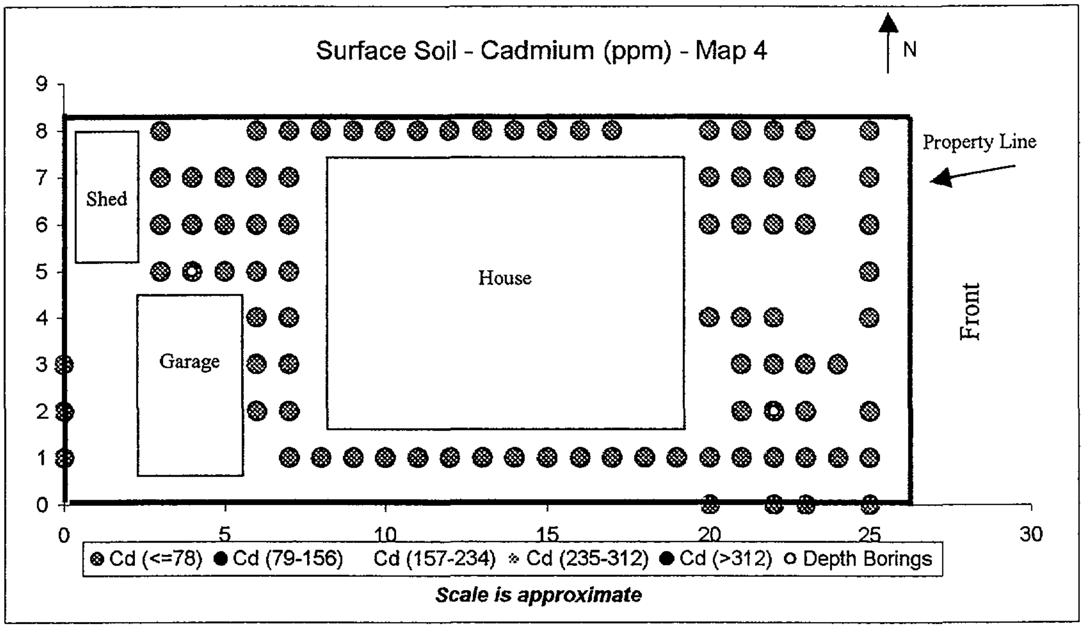
Surface Soil and Depth Profile for Cadmium
Location 3



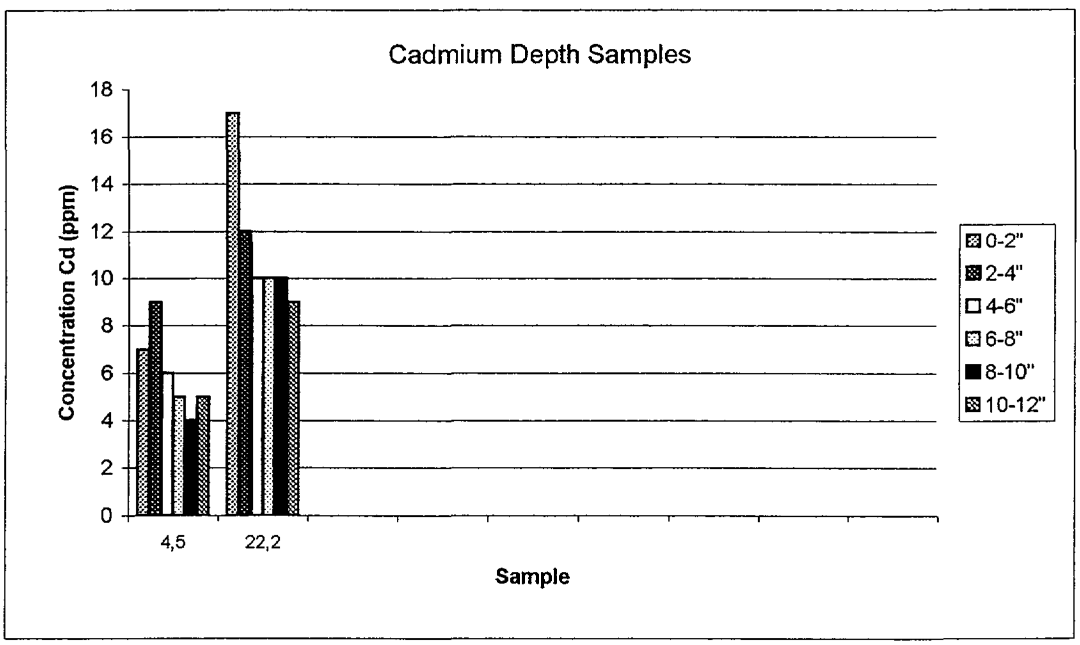
Summary Statistics	N=228
Mean= 6 ppm	Min= 2 ppm
SD= 3 ppm	Max= 22 ppm



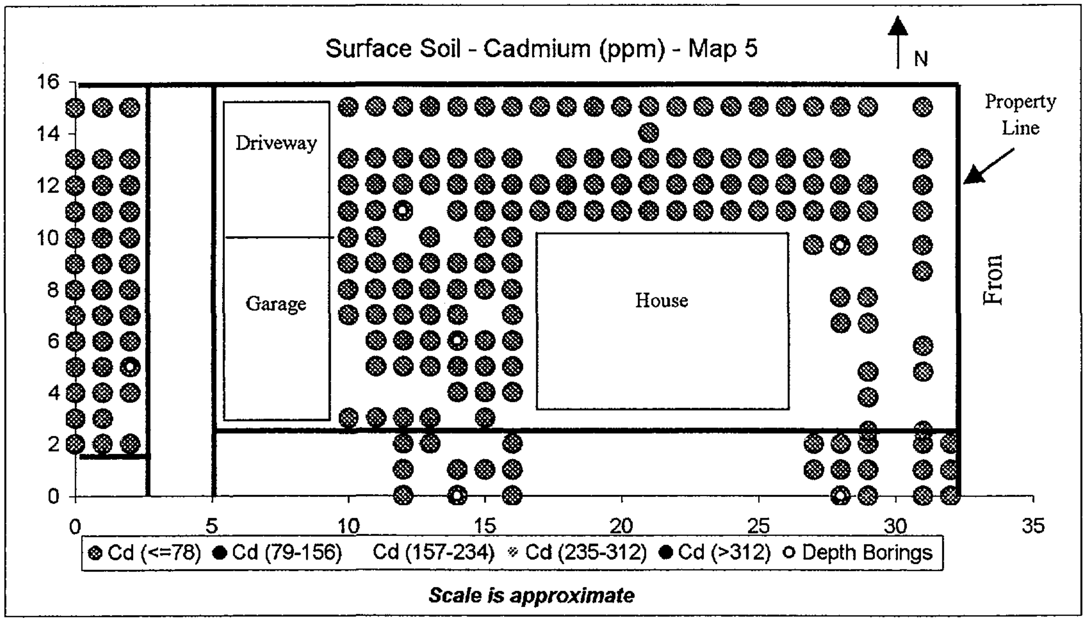
Surface Soil and Depth Profile for Cadmium
Location 4



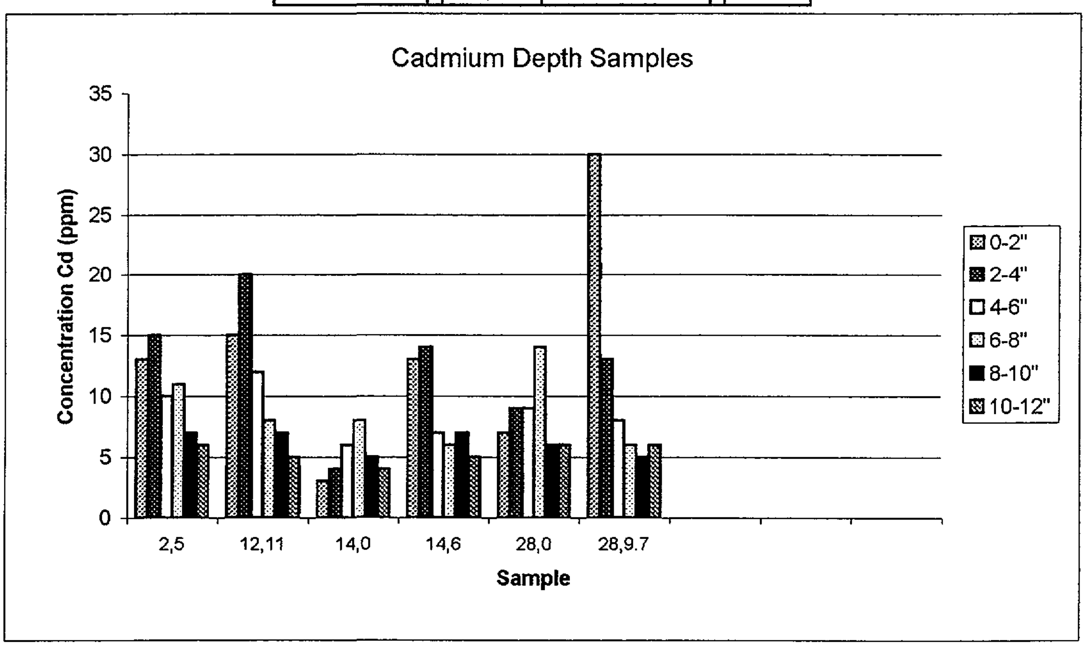
Summary Statistics N=89	
Mean= 13 ppm	Min= 2 ppm
SD= 6 ppm	Max= 39 ppm



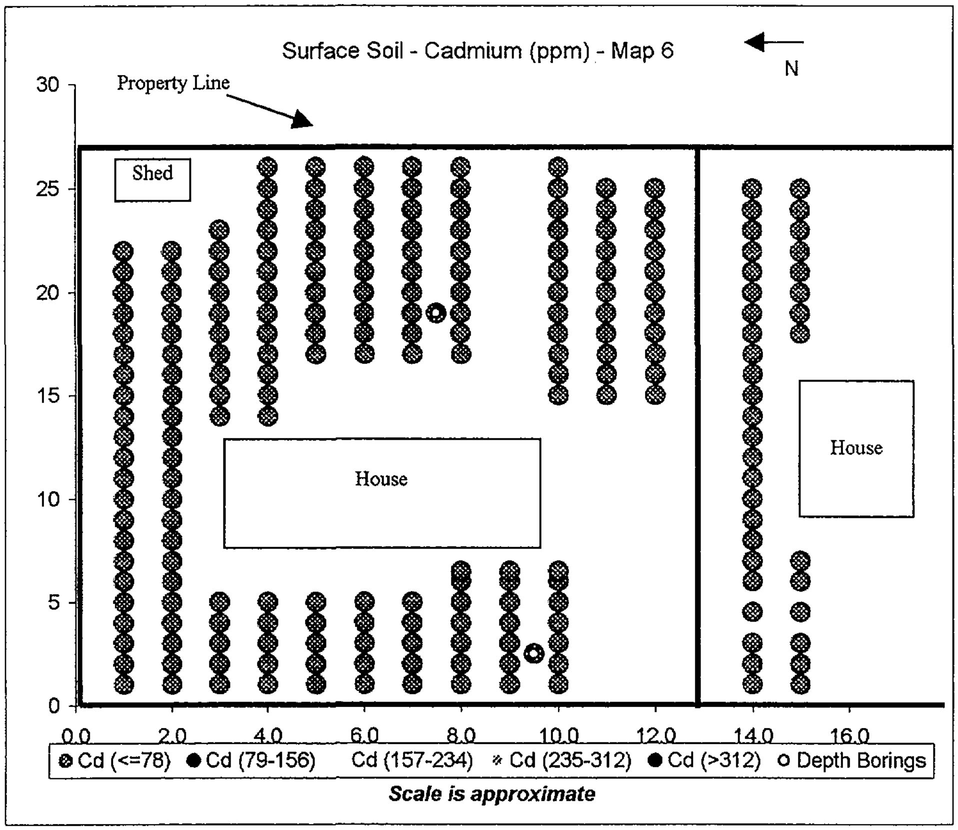
Surface Soil and Depth Profile for Cadmium
Location 5



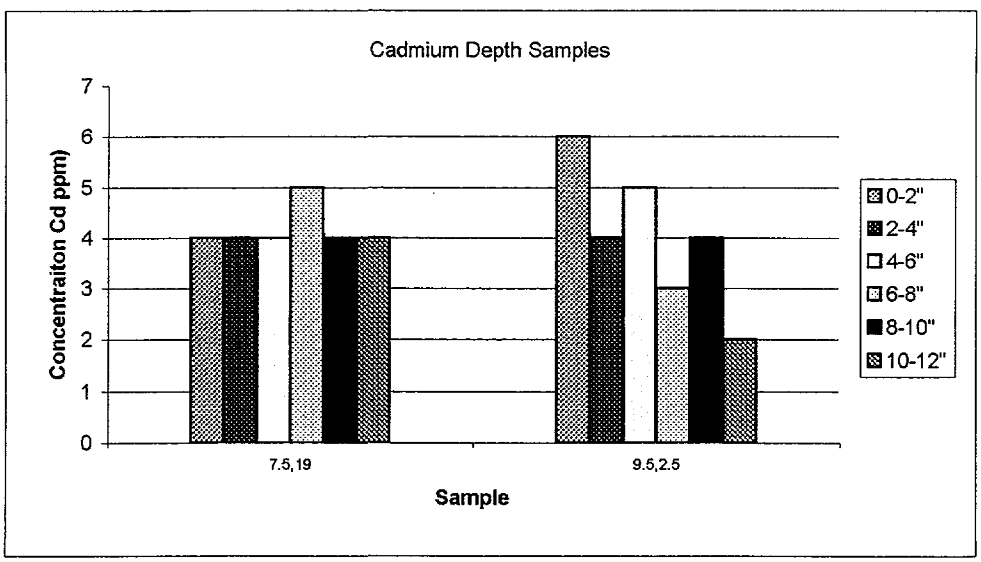
Summary Statistics	N=142
Mean= 15 ppm	Min= 2 ppm
SD= 7 ppm	Max= 30 ppm



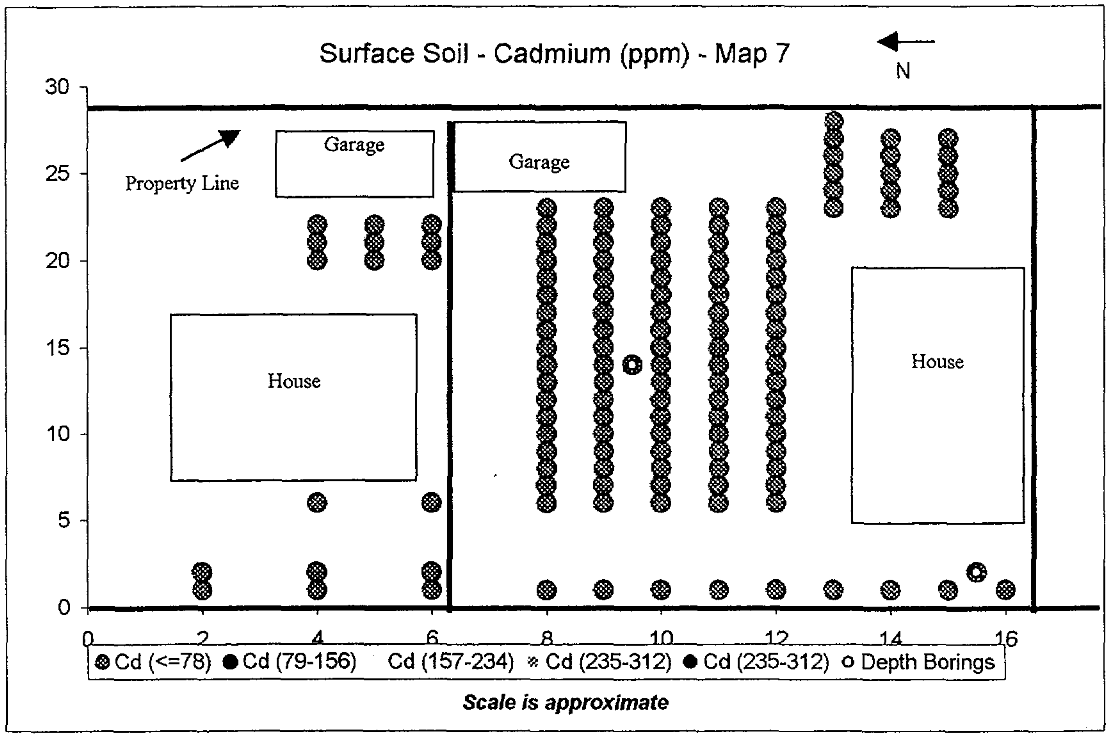
Surface Soil and Depth Profile for Cadmium
Location 6



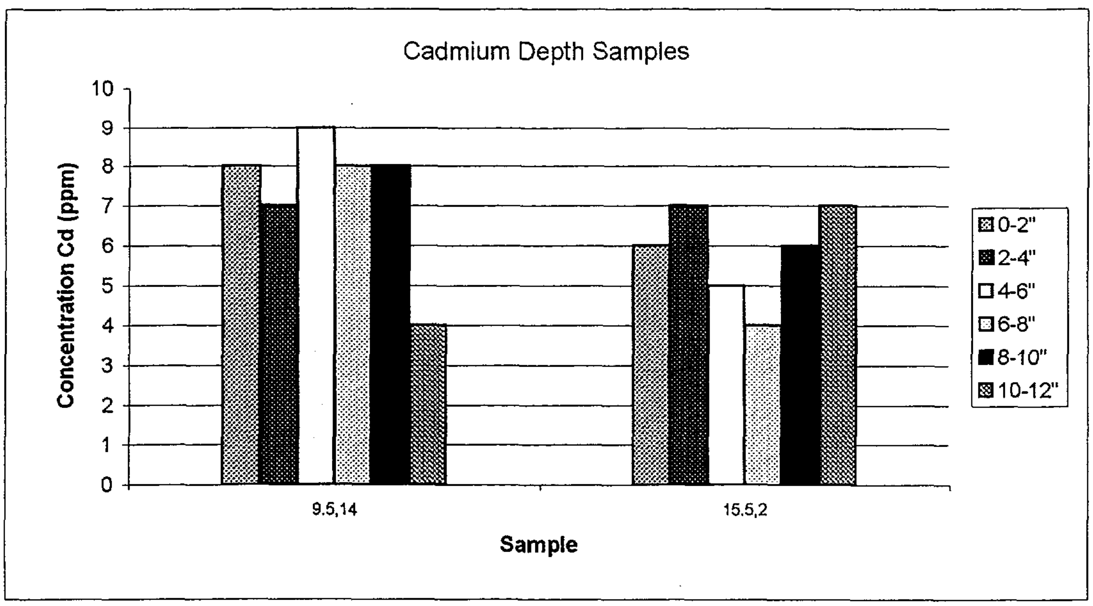
Summary Statistics	N=189
Mean= 4 ppm	Min= 2 ppm
SD= 2 ppm	Max= 8 ppm



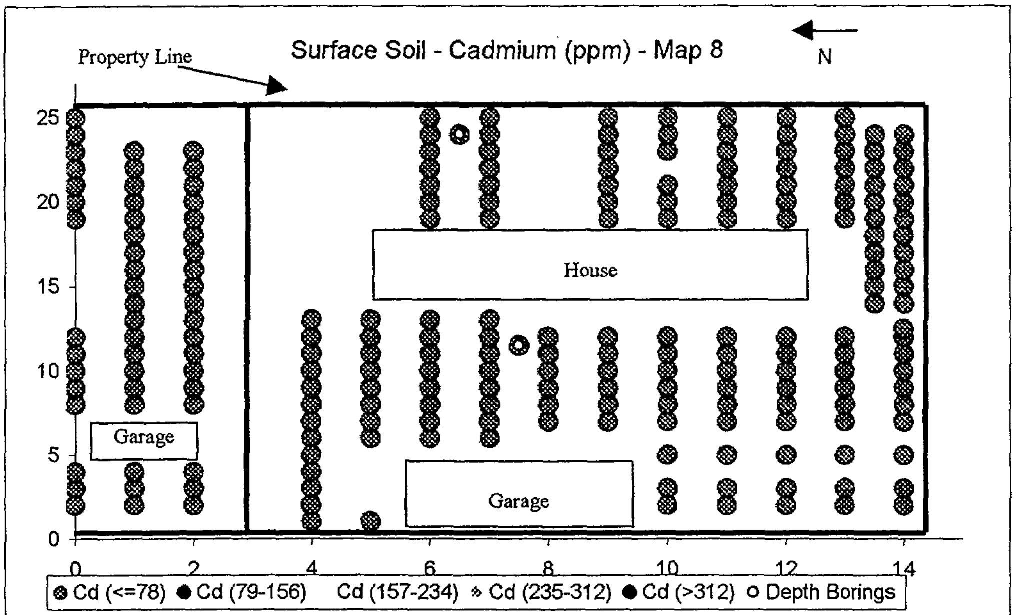
Surface Soil and Depth Profile for Cadmium
Location 7



Summary Statistics	N=117
Mean= 7 ppm	Min= 2 ppm
SD= 3 ppm	Max= 19 ppm

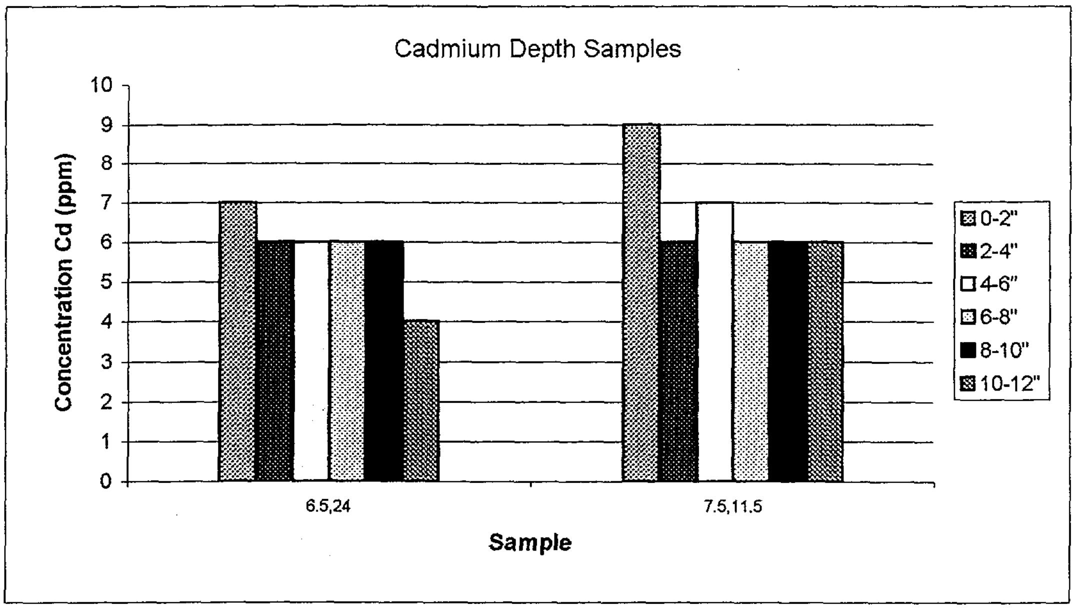


Surface Soil and Depth Profile for Cadmium
Location 8



Scale is approximate

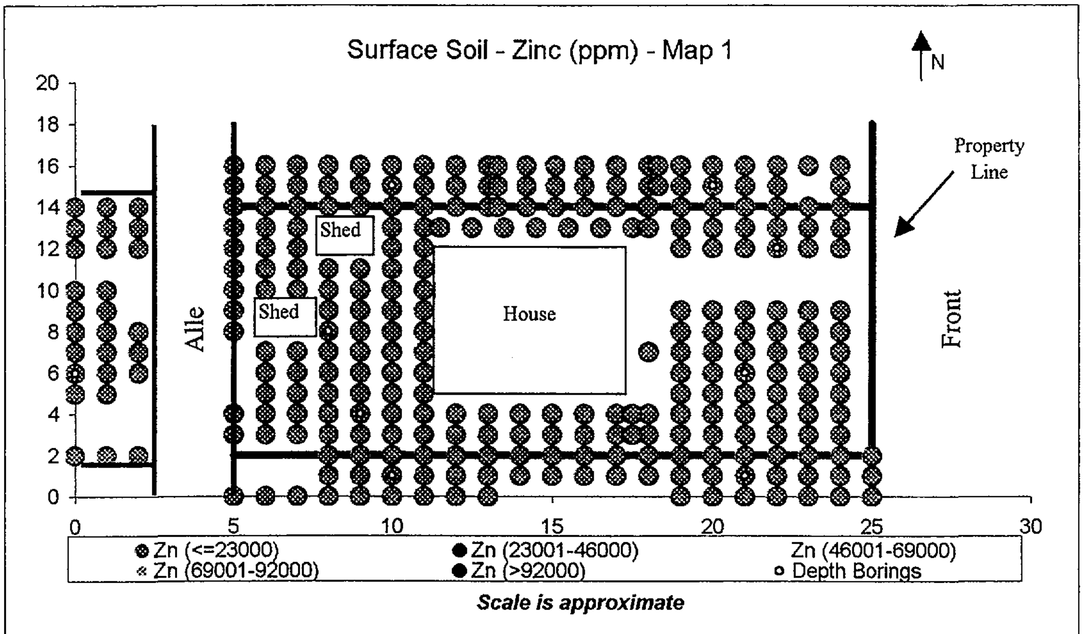
Summary Statistics	N=166
Mean= 7 ppm	Min= 2 ppm
SD= 2 ppm	Max= 13 ppm



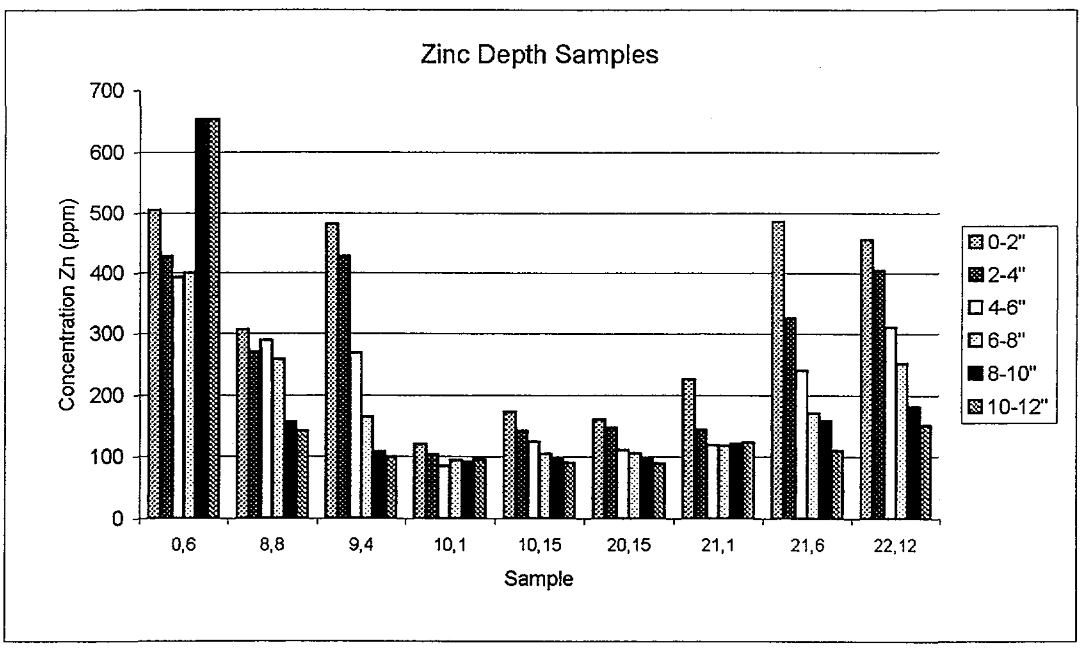
APPENDIX E4

Surface Soil and Depth Profile for Zinc

Surface Soil and Depth Profile for Zinc
Location 1

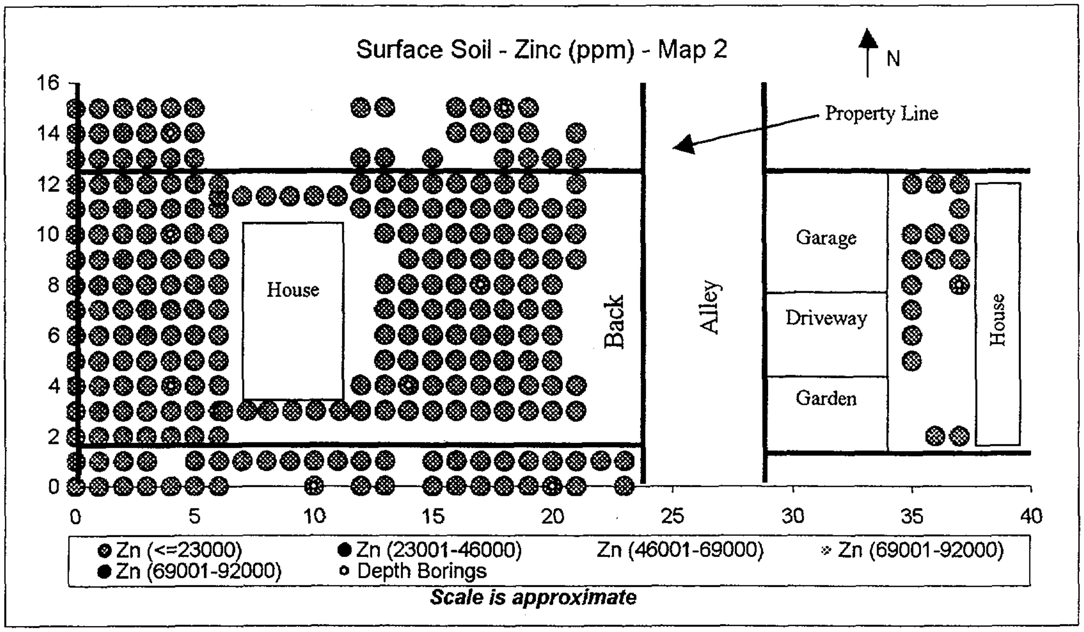


Summary Statistics	N=152
Mean= 491 ppm	Min= 159 ppm
SD= 536 ppm	Max= 5003 ppm

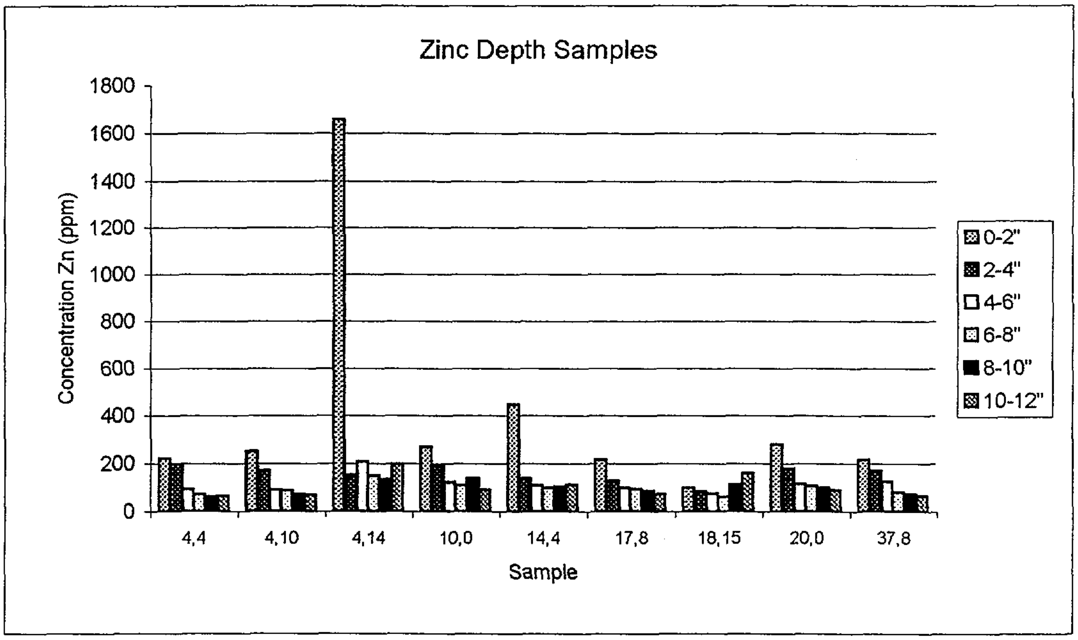


E4-1

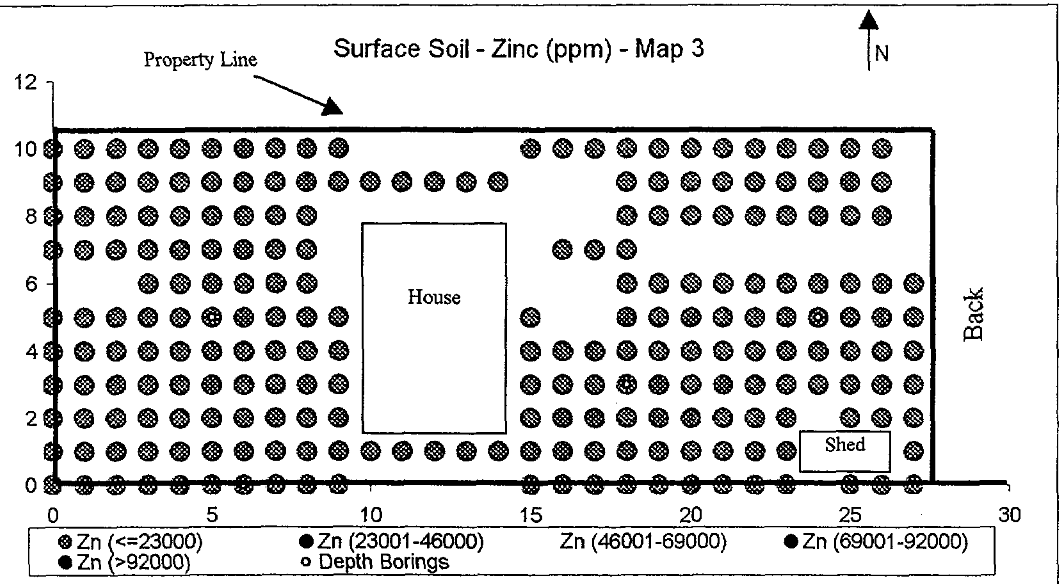
Surface Soil and Depth Profile for Zinc
Location 2



Summary Statistics	N=177
Mean= 303 ppm	Min= 48 ppm
SD= 146 ppm	Max= 1533 ppm

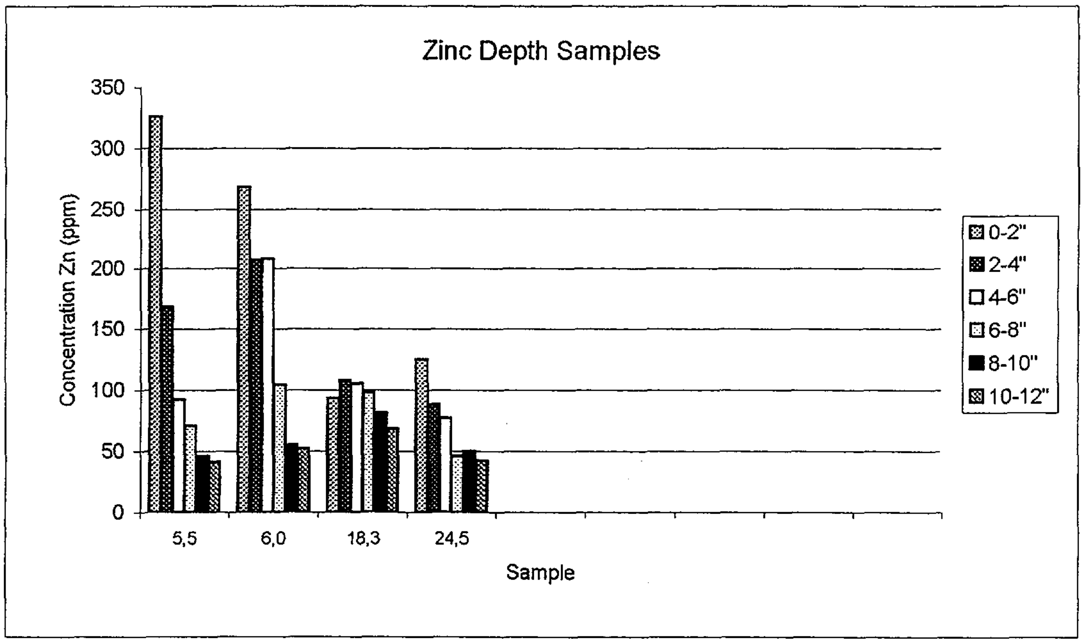


Surface Soil and Depth Profile for Zinc
Location 3

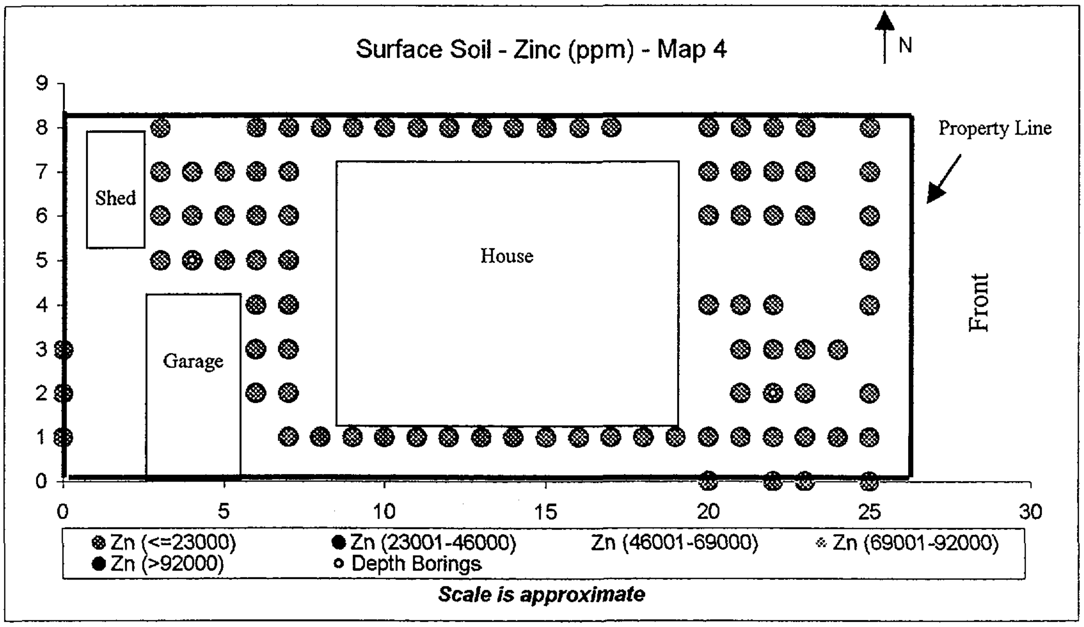


Scale is approximate

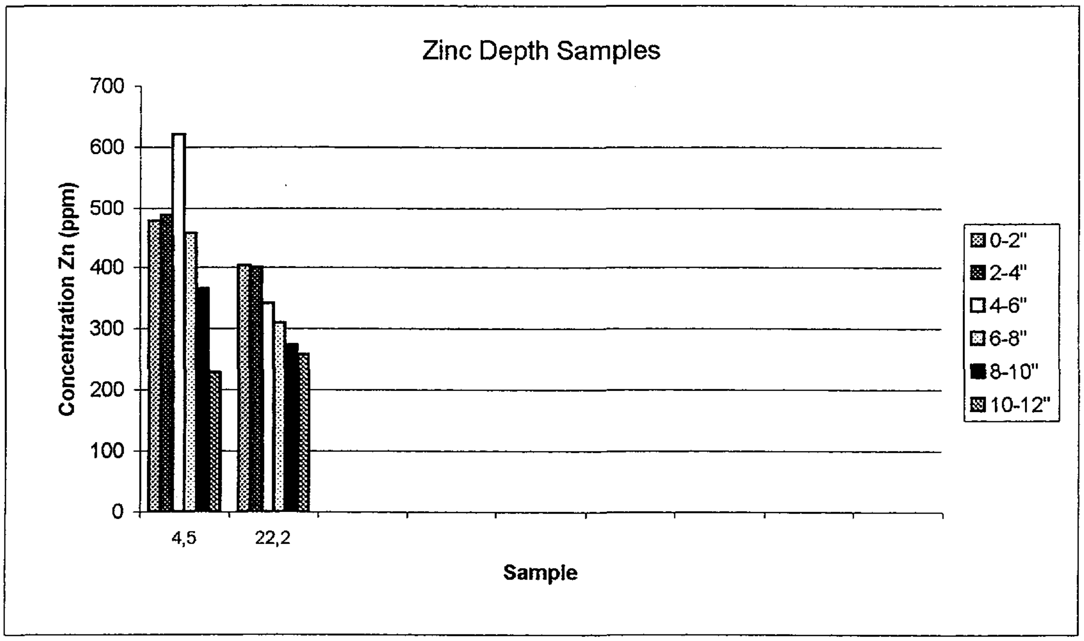
Summary Statistics	N=228
Mean= 221 ppm	Min= 56 ppm
SD= 125 ppm	Max= 1203 ppm



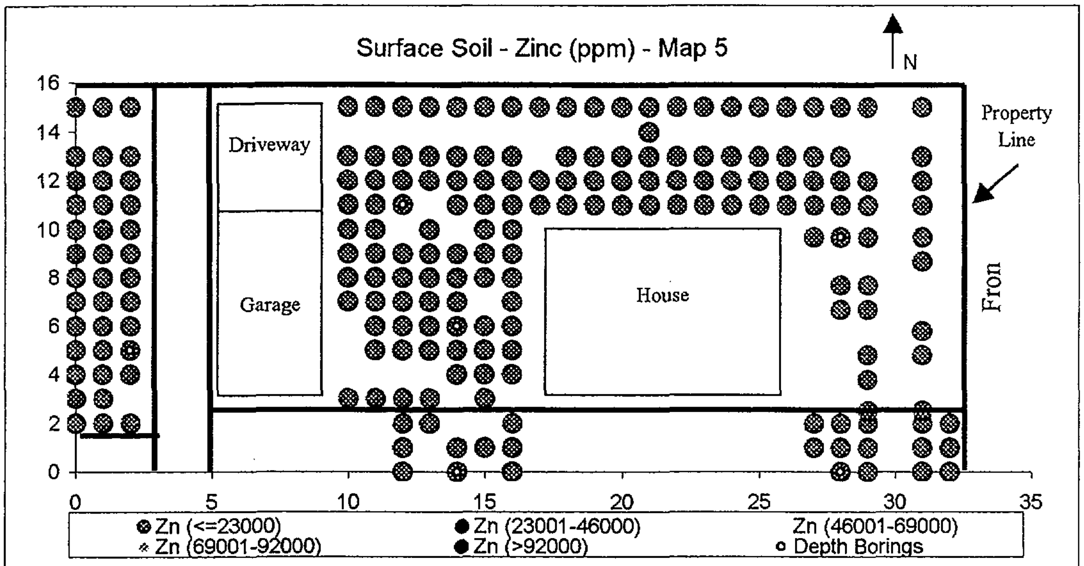
Surface Soil and Depth Profile for Zinc
Location 4



Summary Statistics	N=89
Mean= 574 ppm	Min= 63 ppm
SD= 273 ppm	Max= 1455 ppm

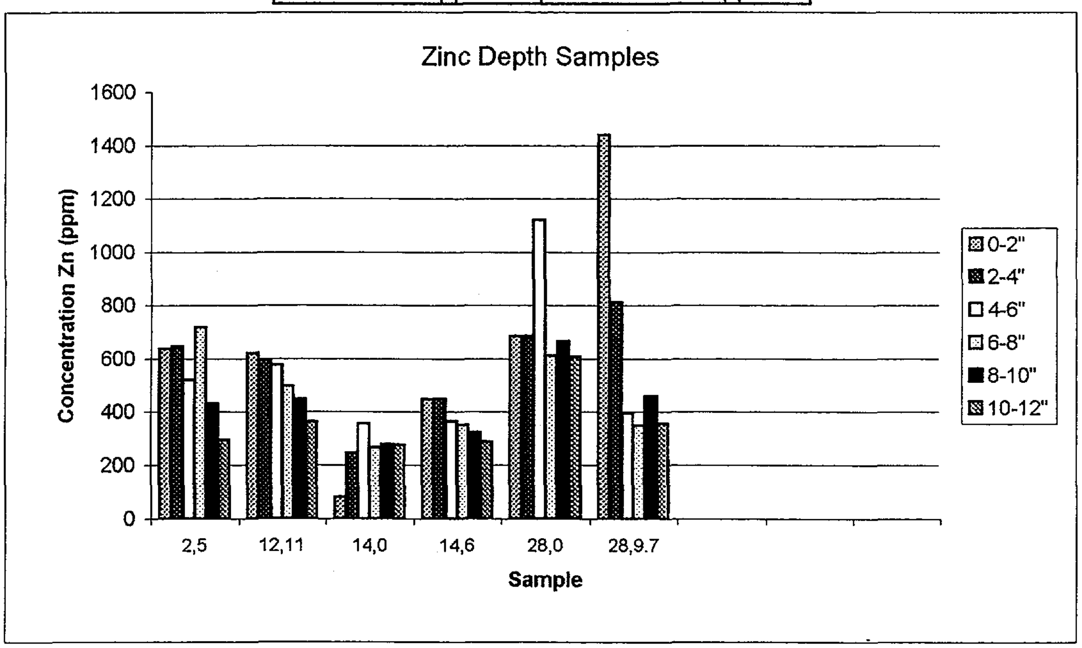


Surface Soil and Depth Profile for Zinc
Location 5

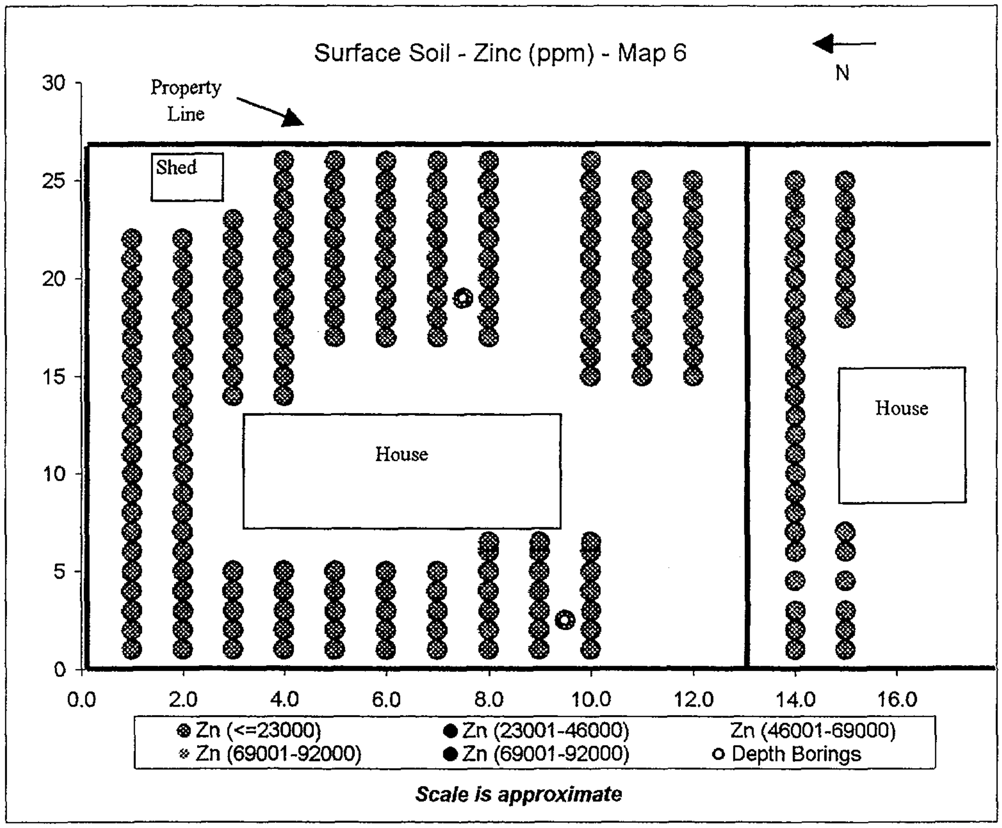


Scale is approximate

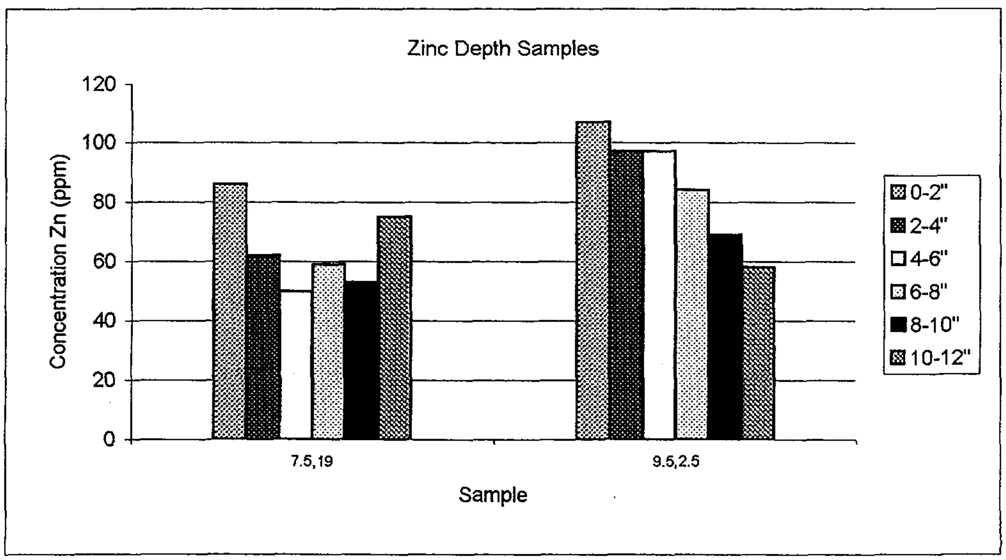
Summary Statistics	N=142
Mean= 652 ppm	Min= 113 ppm
SD= 382 ppm	Max= 3526 ppm



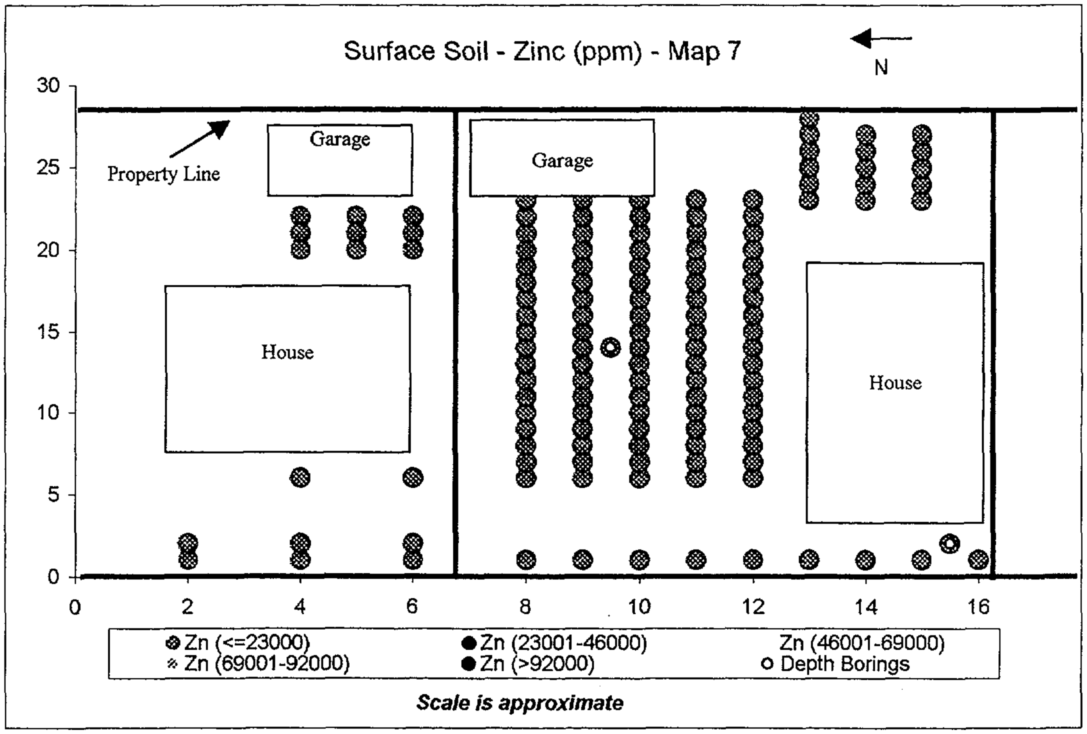
Surface Soil and Depth Profile for Zinc
Location 6



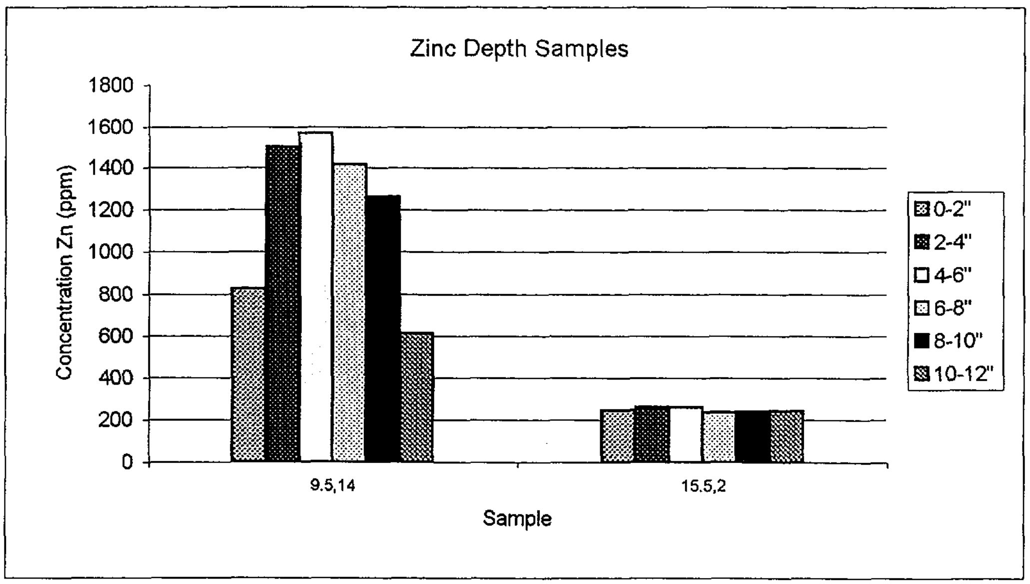
Summary Statistics N=189	
Mean= 113 ppm	Min= 42 ppm
SD= 69 ppm	Max= 621 ppm



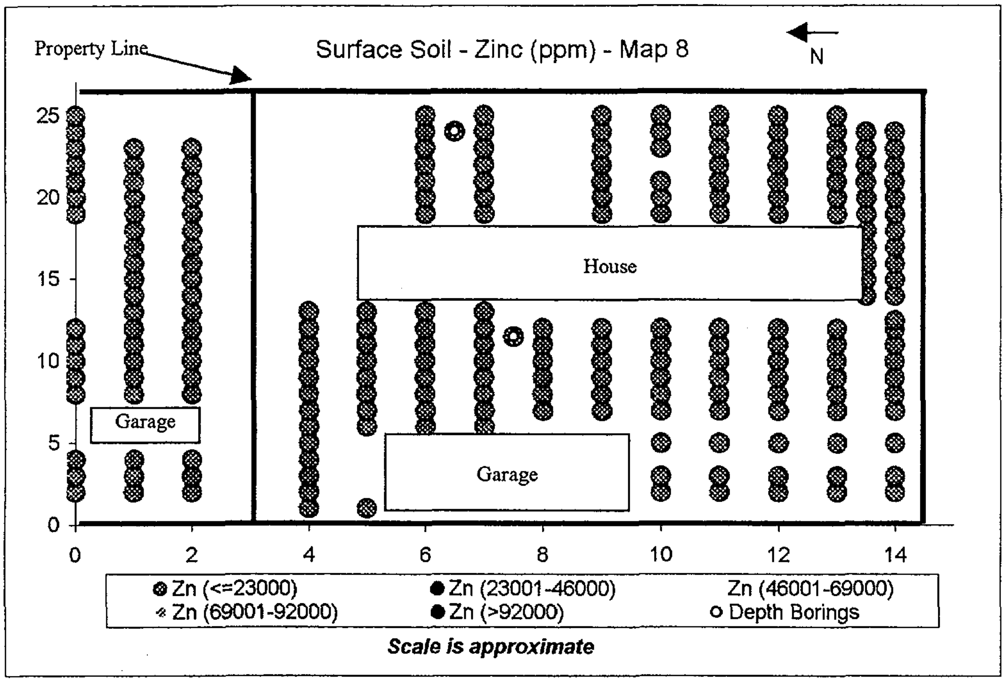
Surface Soil and Depth Profile for Zinc
Location 7



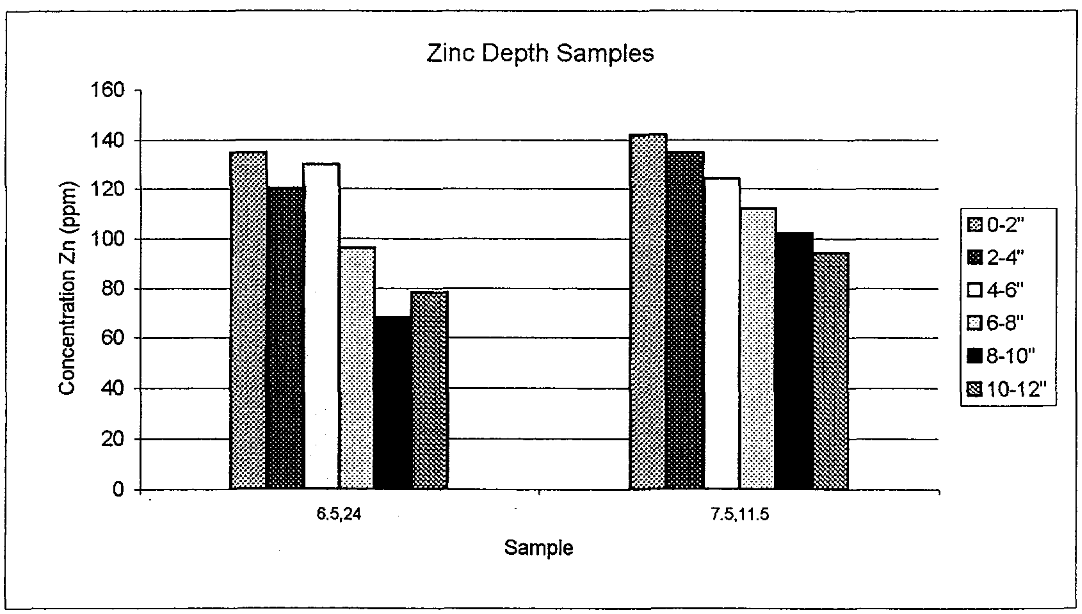
Summary Statistics	N=117
Mean= 410 ppm	Min= 174 ppm
SD= 179 ppm	Max= 1036 ppm



Surface Soil and Depth Profile for Zinc
Location 8



Summary Statistics	N=166
Mean= 224 ppm	Min= 65 ppm
SD= 135 ppm	Max= 1172 ppm



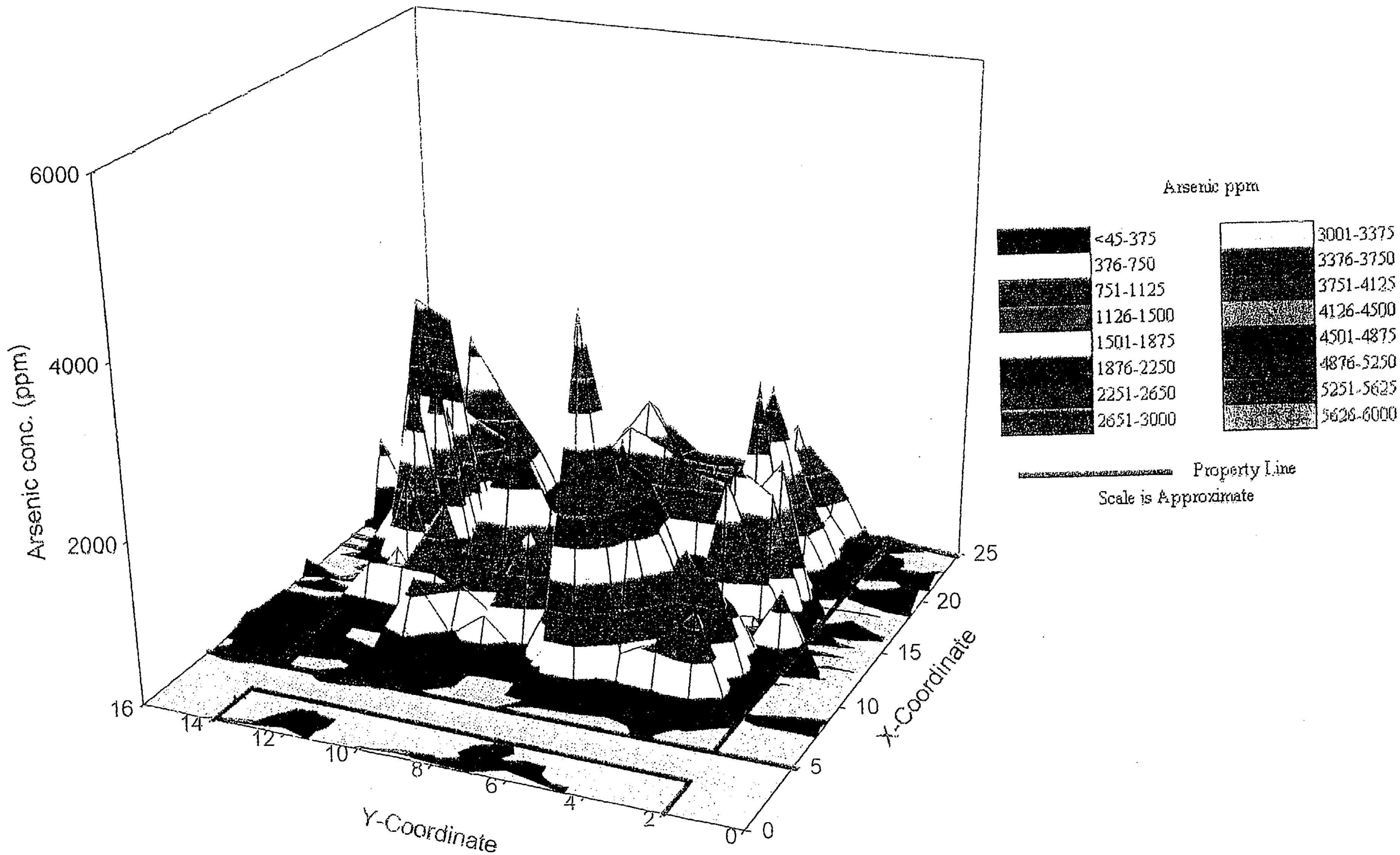
APPENDIX F

Risk Based Sampling 3-D Surface Plots For Arsenic and Lead

APPENDIX F1

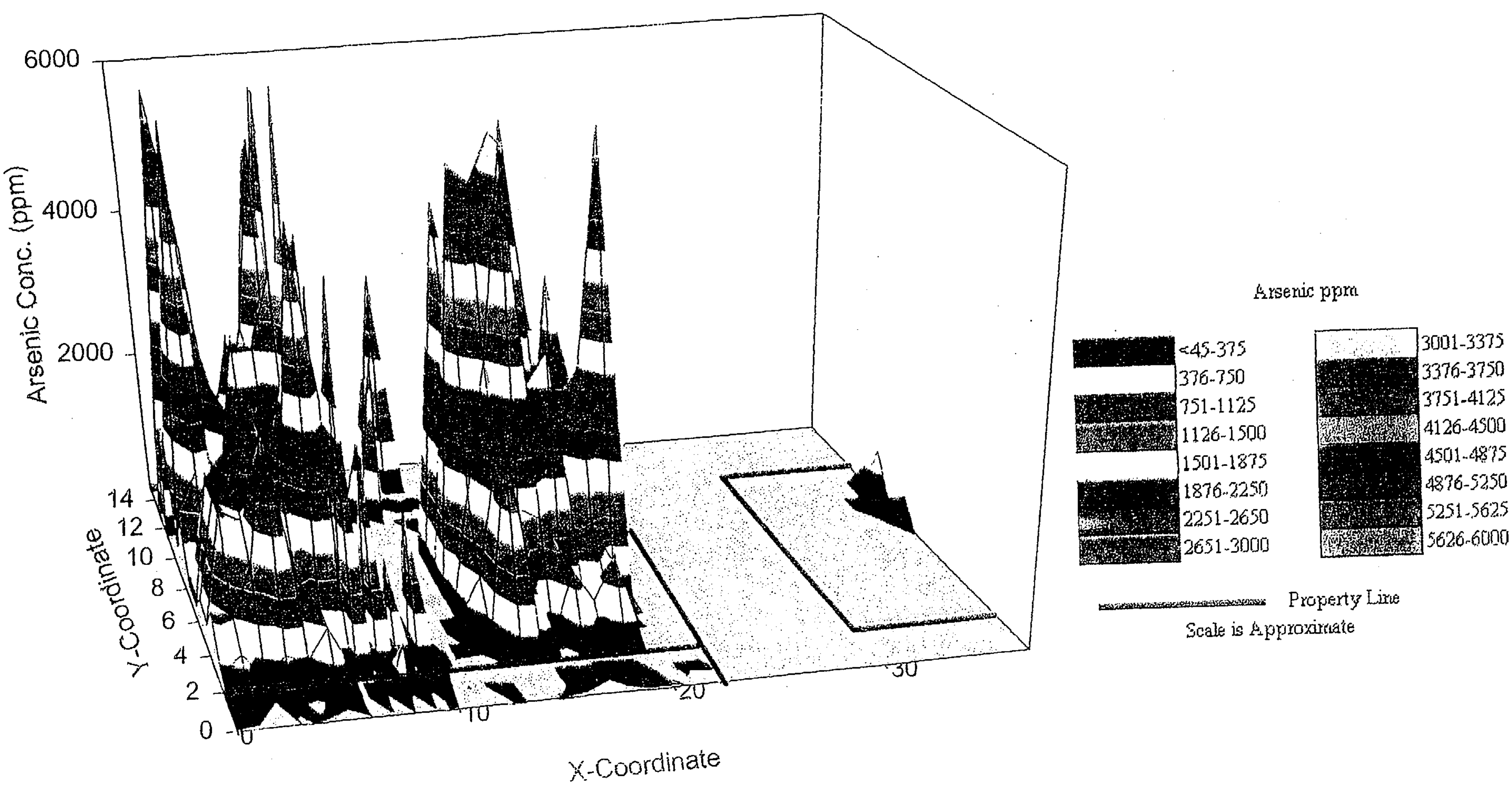
Arsenic Concentrations

Arsenic Concentrations - Location 1

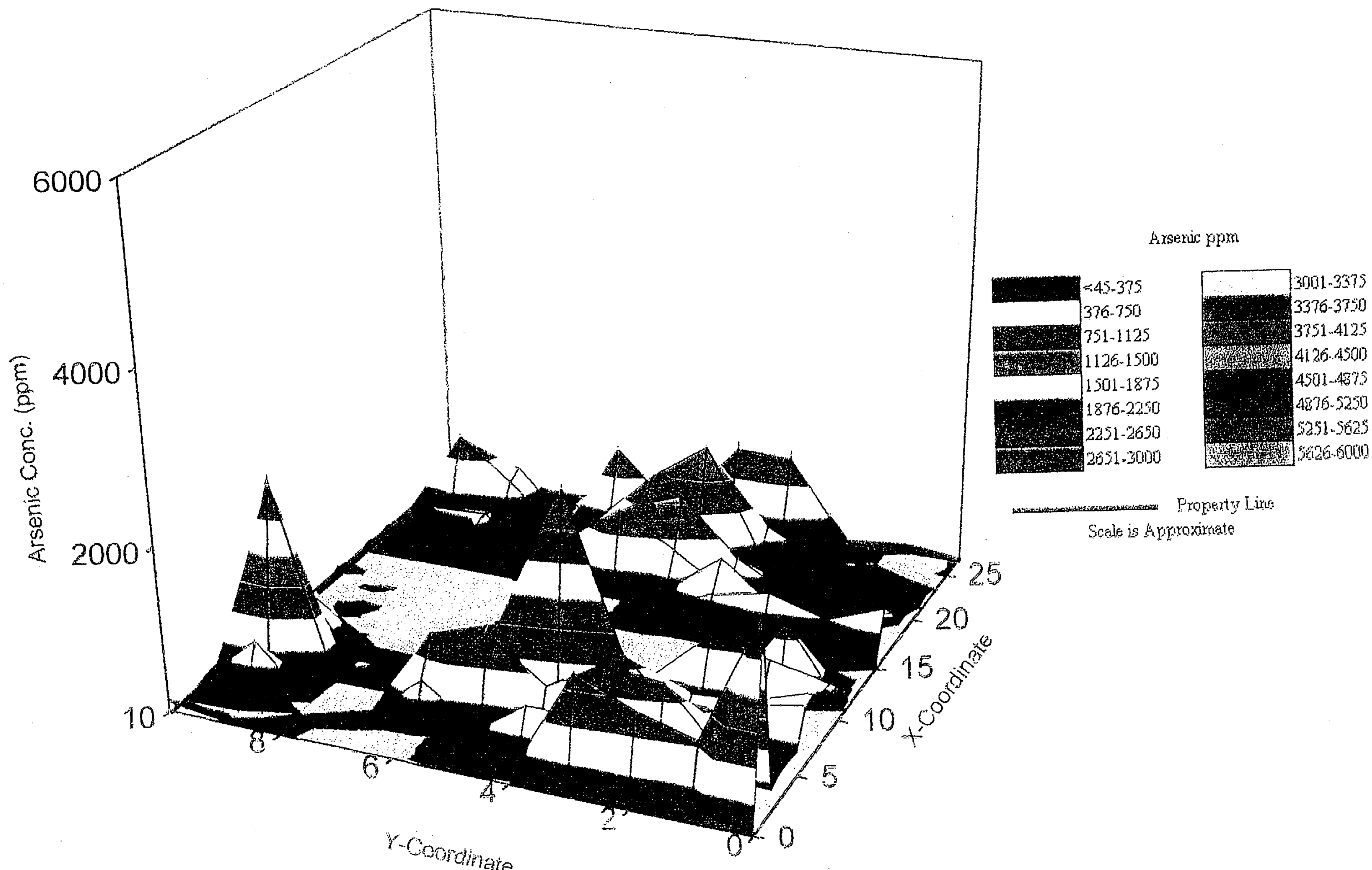


F1-1

Arsenic Concentrations - Location 2

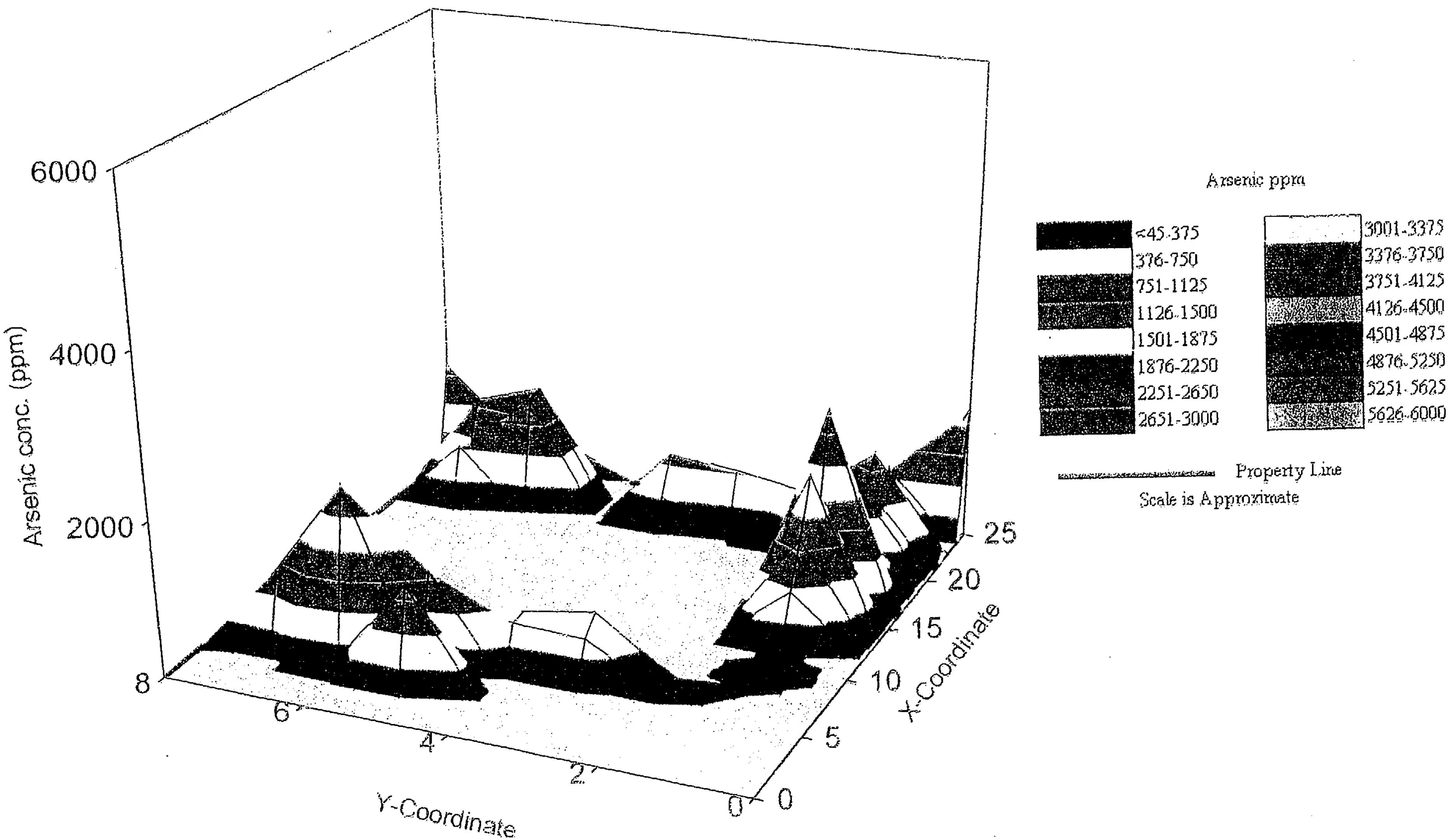


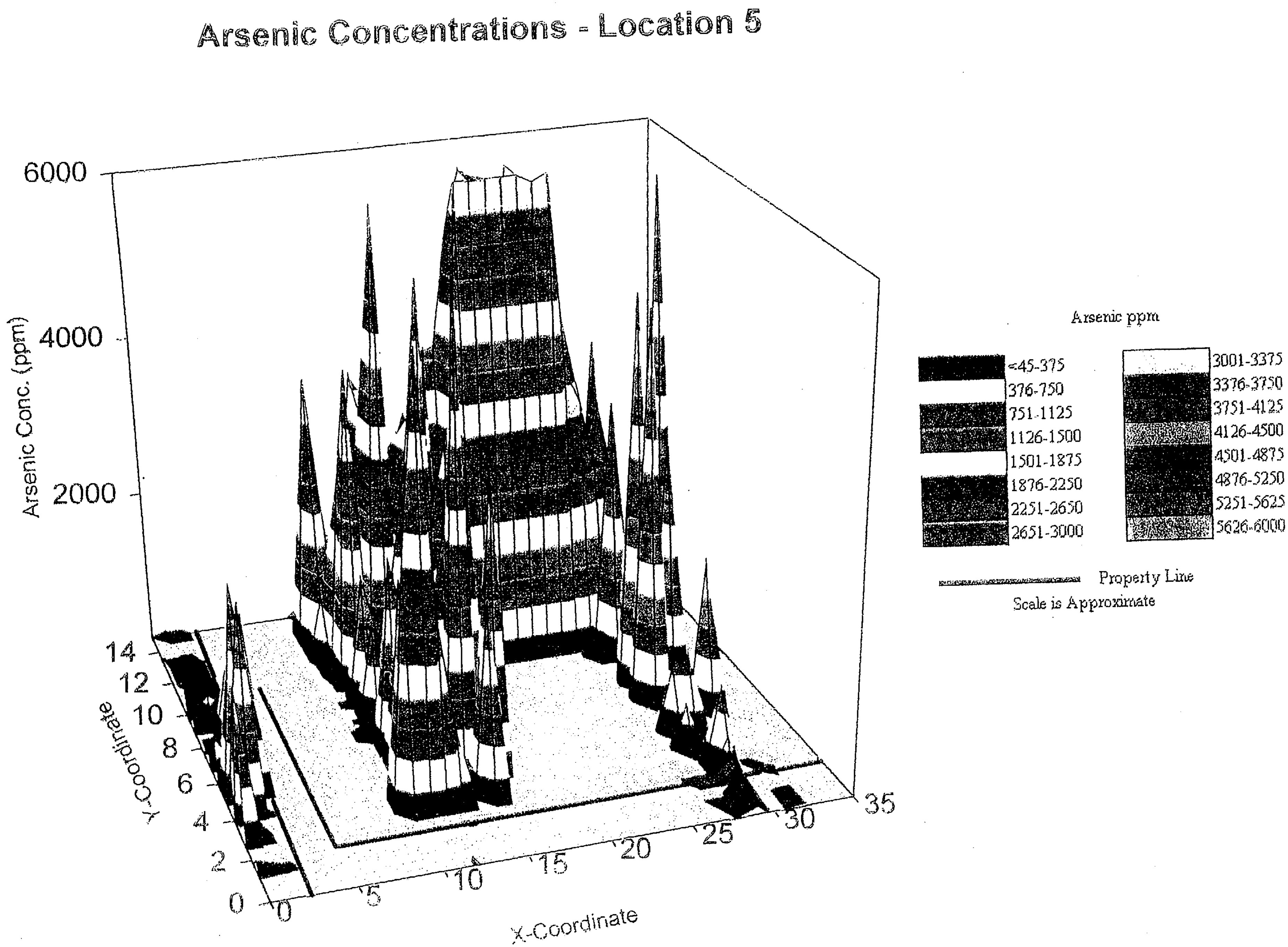
Arsenic Concentrations - Location 3



F1-3

Arsenic Concentrations - Location 4

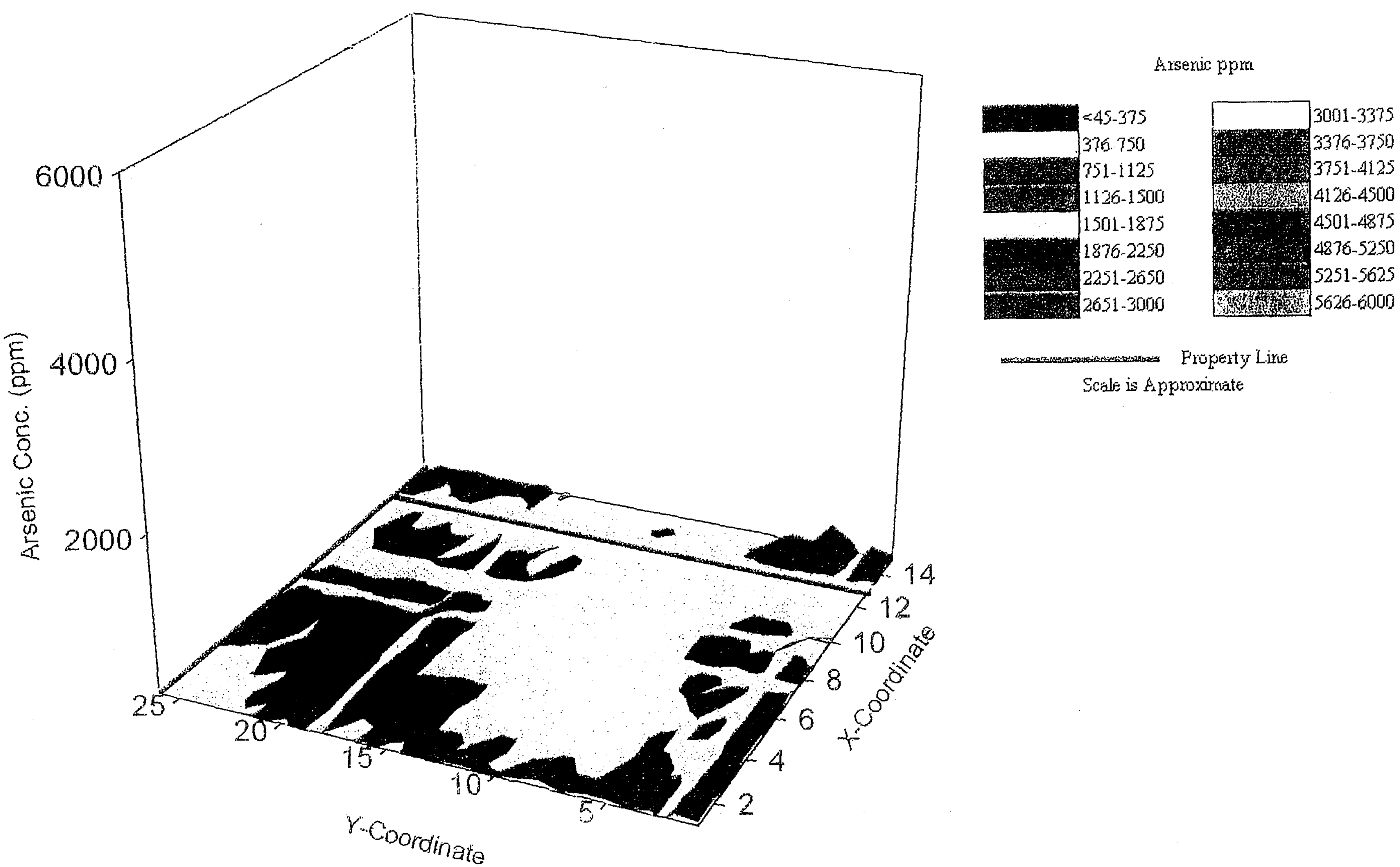




Arsenic Concentrations - Location 5
6000
4000
2000
Arsenic Conc. (ppm)
14
12
10
8
6
4
2
0
Y-Coordinate
0
5
10
15
20
25
30
35
X-Coordinate
Arsenic ppm
<45-375
376-750
751-1125
1126-1500
1501-1875
1876-2250
2251-2650
2651-3000
3001-3375
3376-3750
3751-4125
4126-4500
4501-4875
4876-5250
5251-5625
5626-6000
Property Line
Scale is Approximate

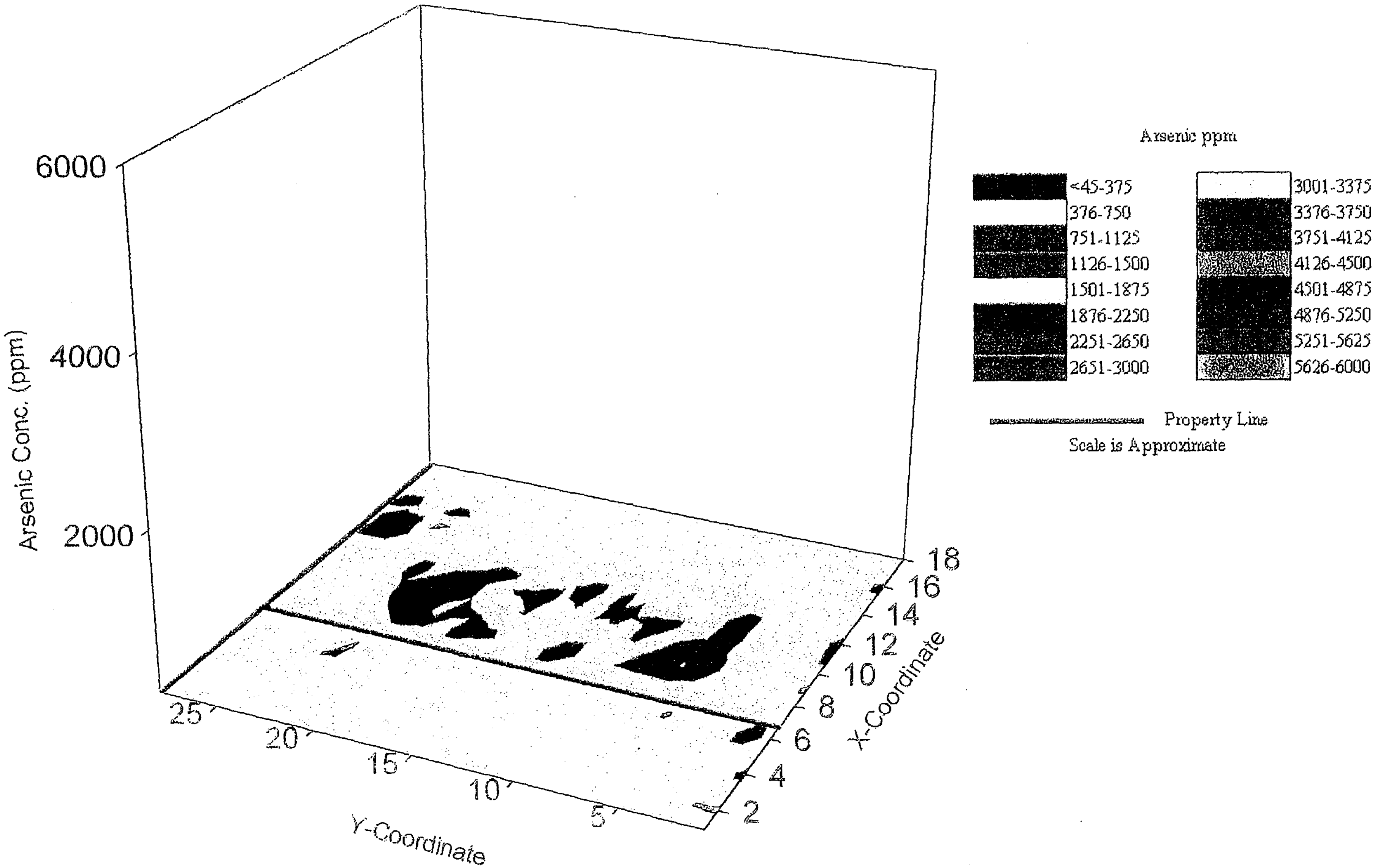
F1-5

Arsenic Concentrations - Location 6



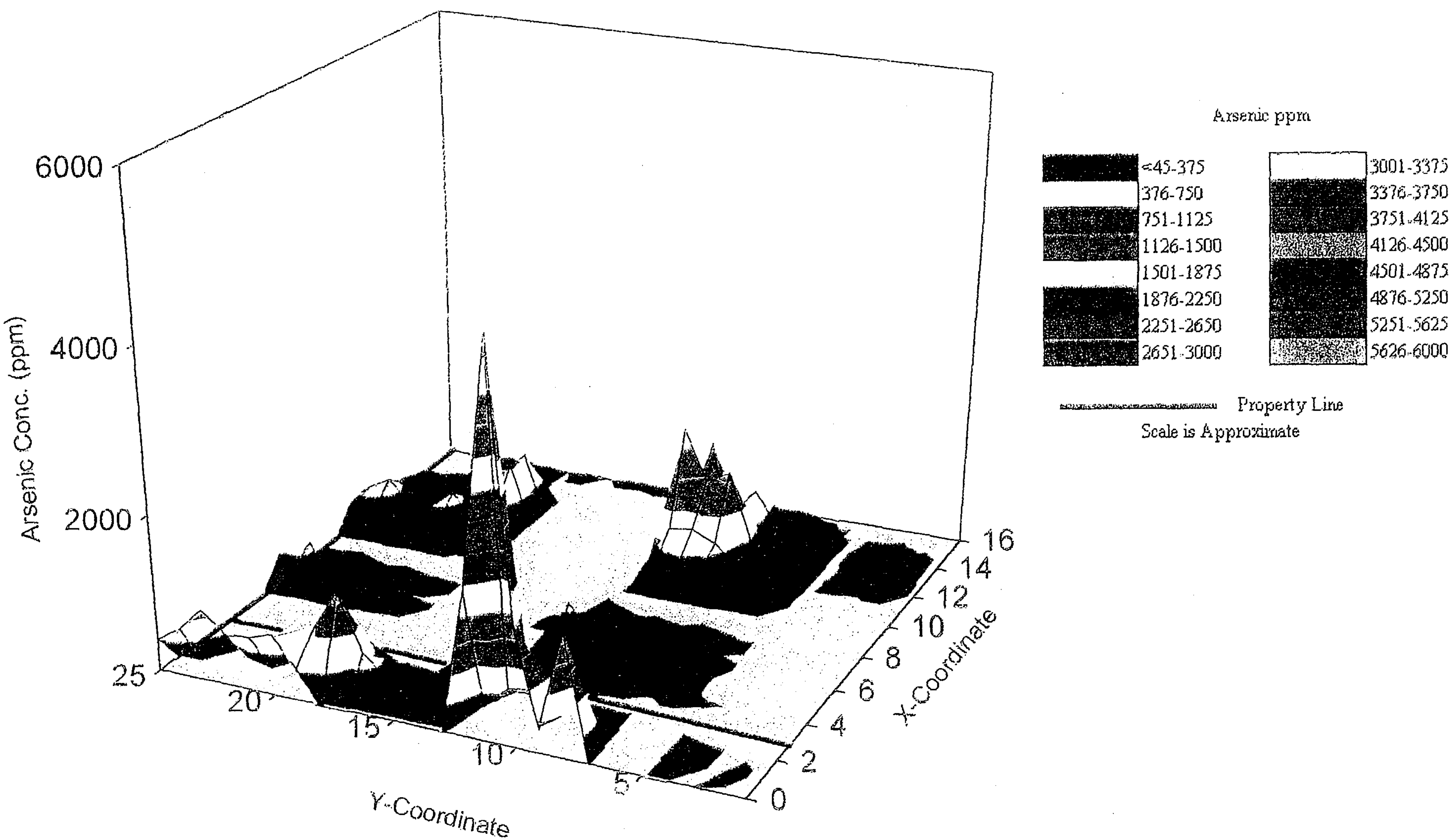
F1-6

Arsenic Concentrations - Location 7



F1-7

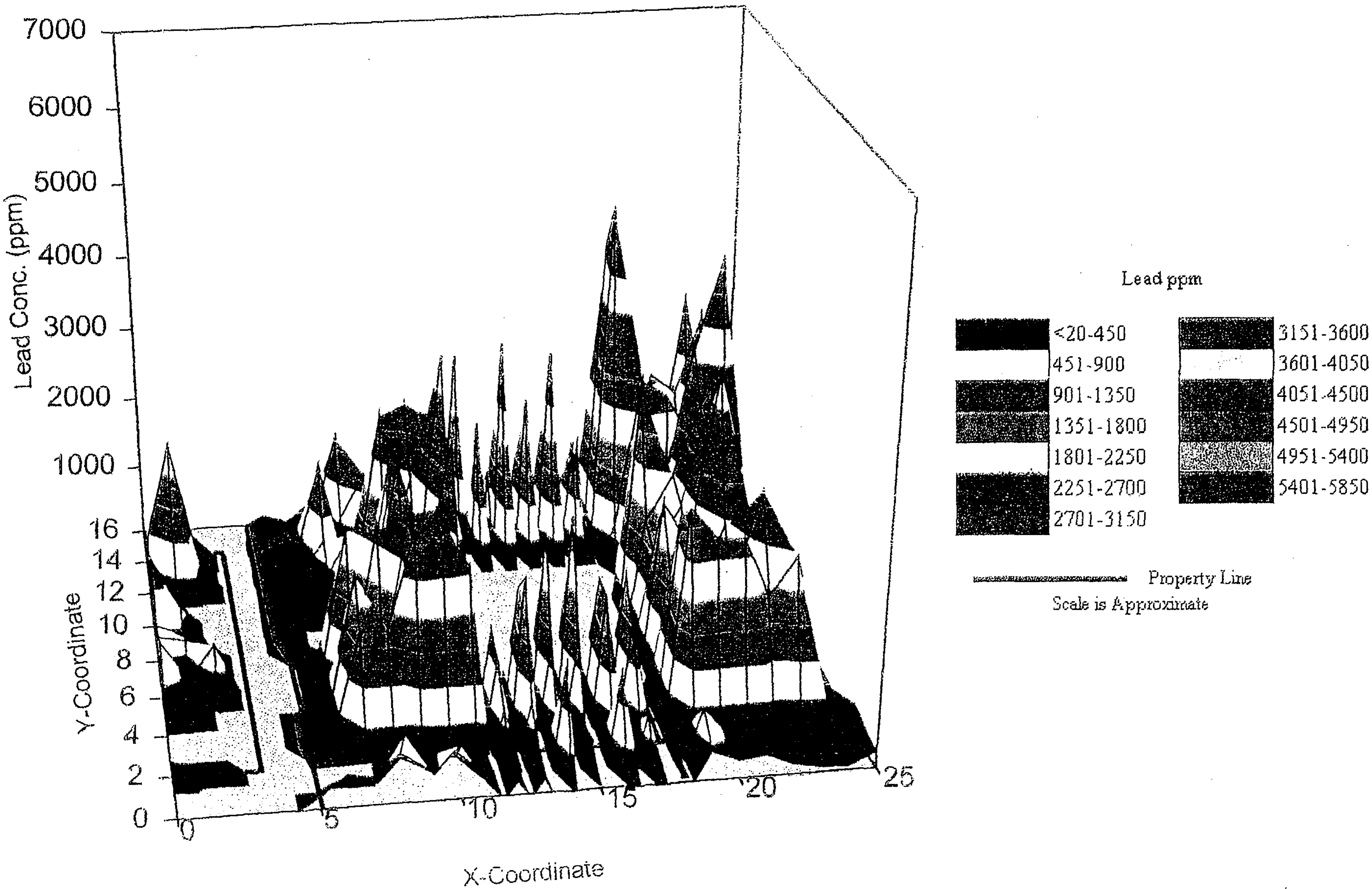
Arsenic Concentrations - Location 8



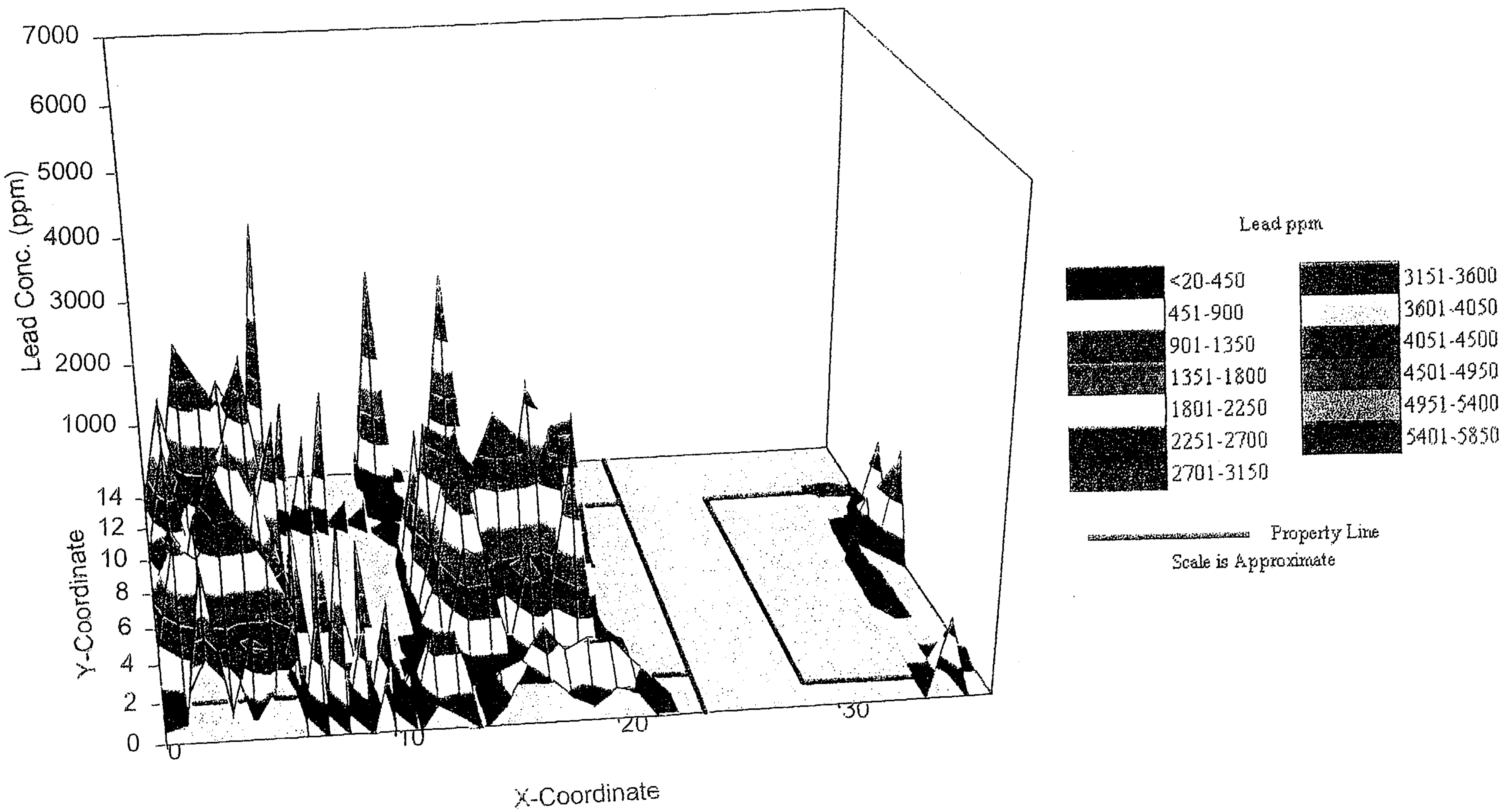
APPENDIX F2

Lead Concentrations

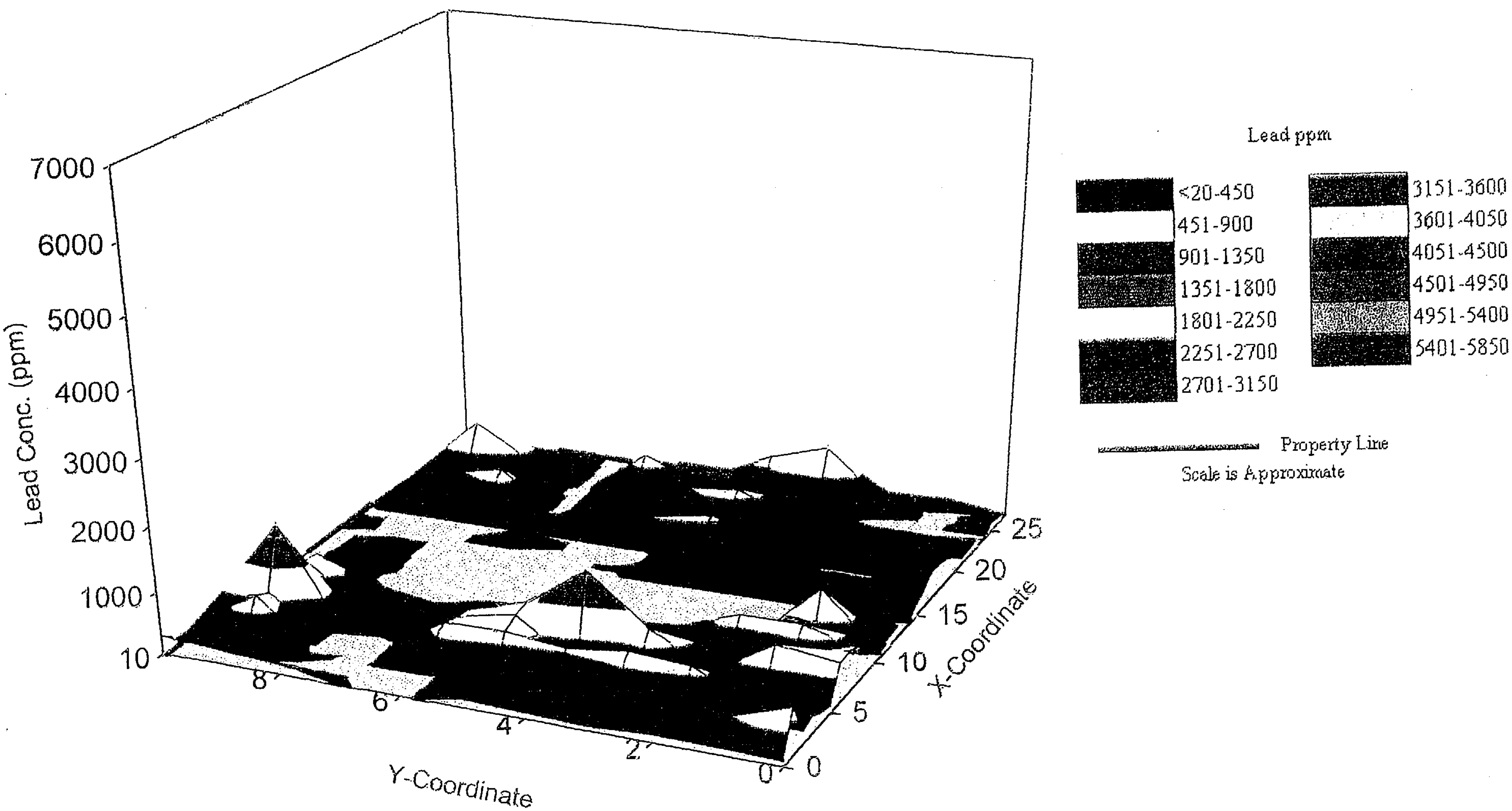
Lead Concentrations - Location 1



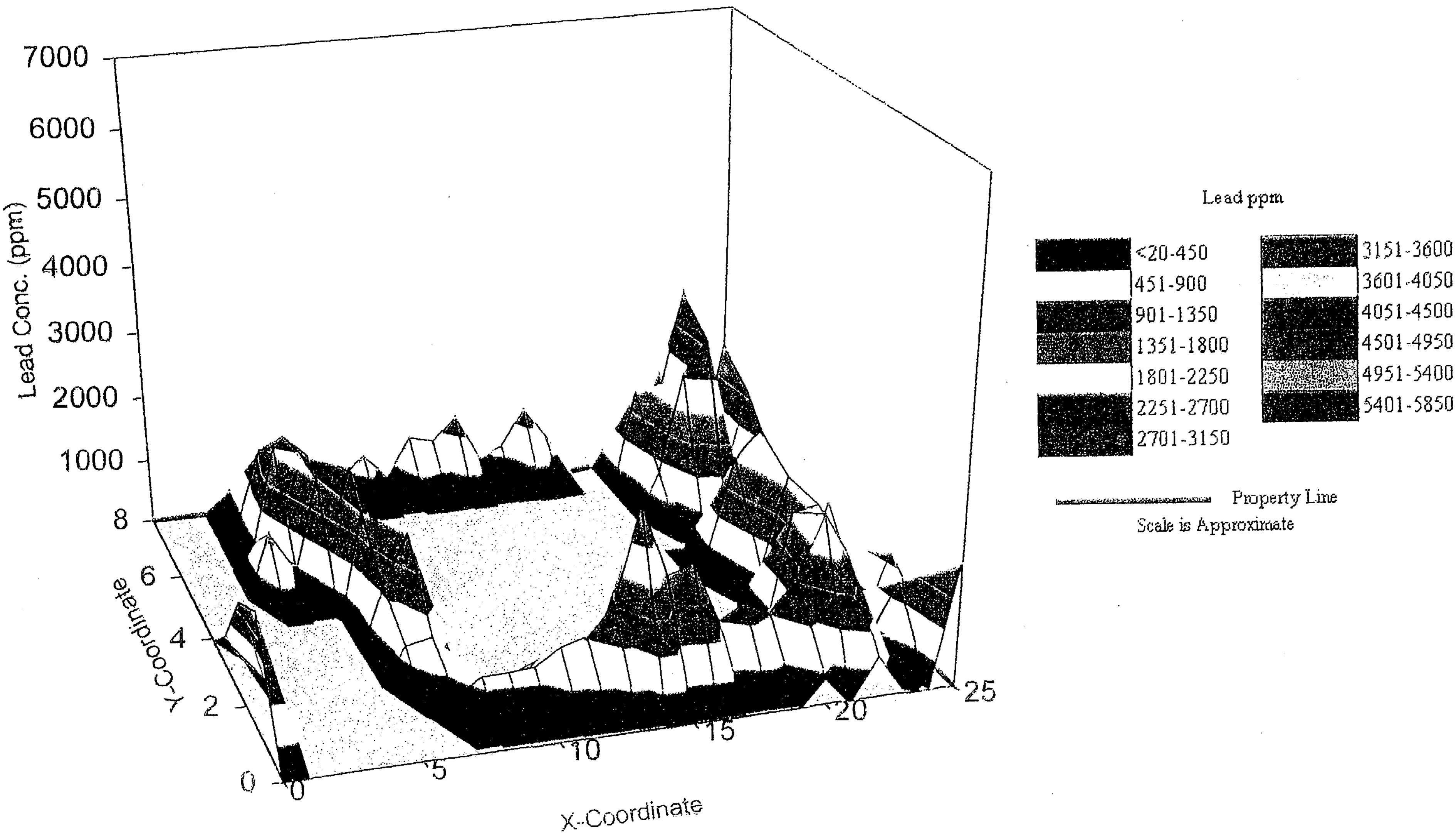
Lead Concentrations - Location 2



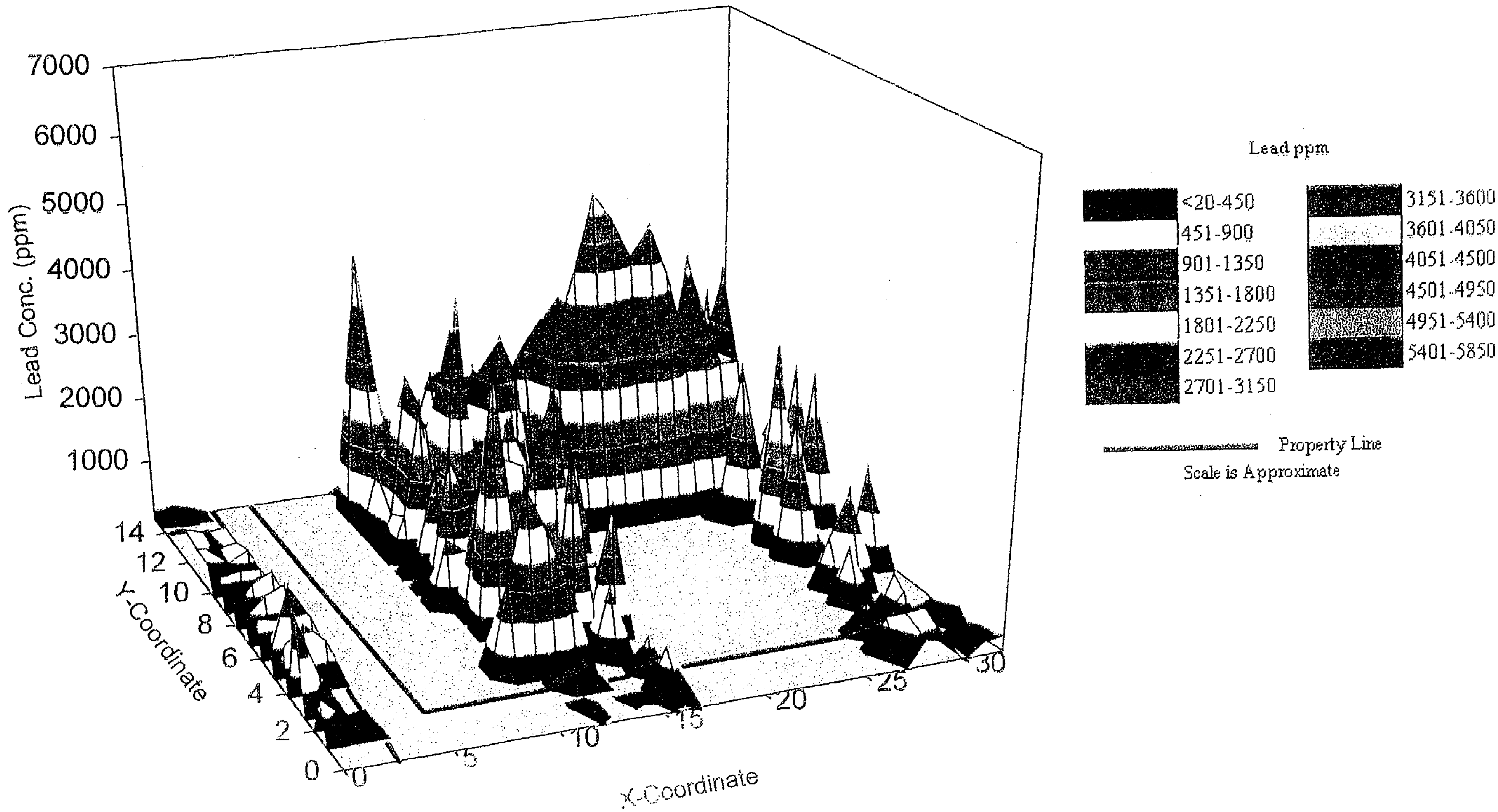
Lead Concentrations - Location 3



Lead Concentrations - Location 4

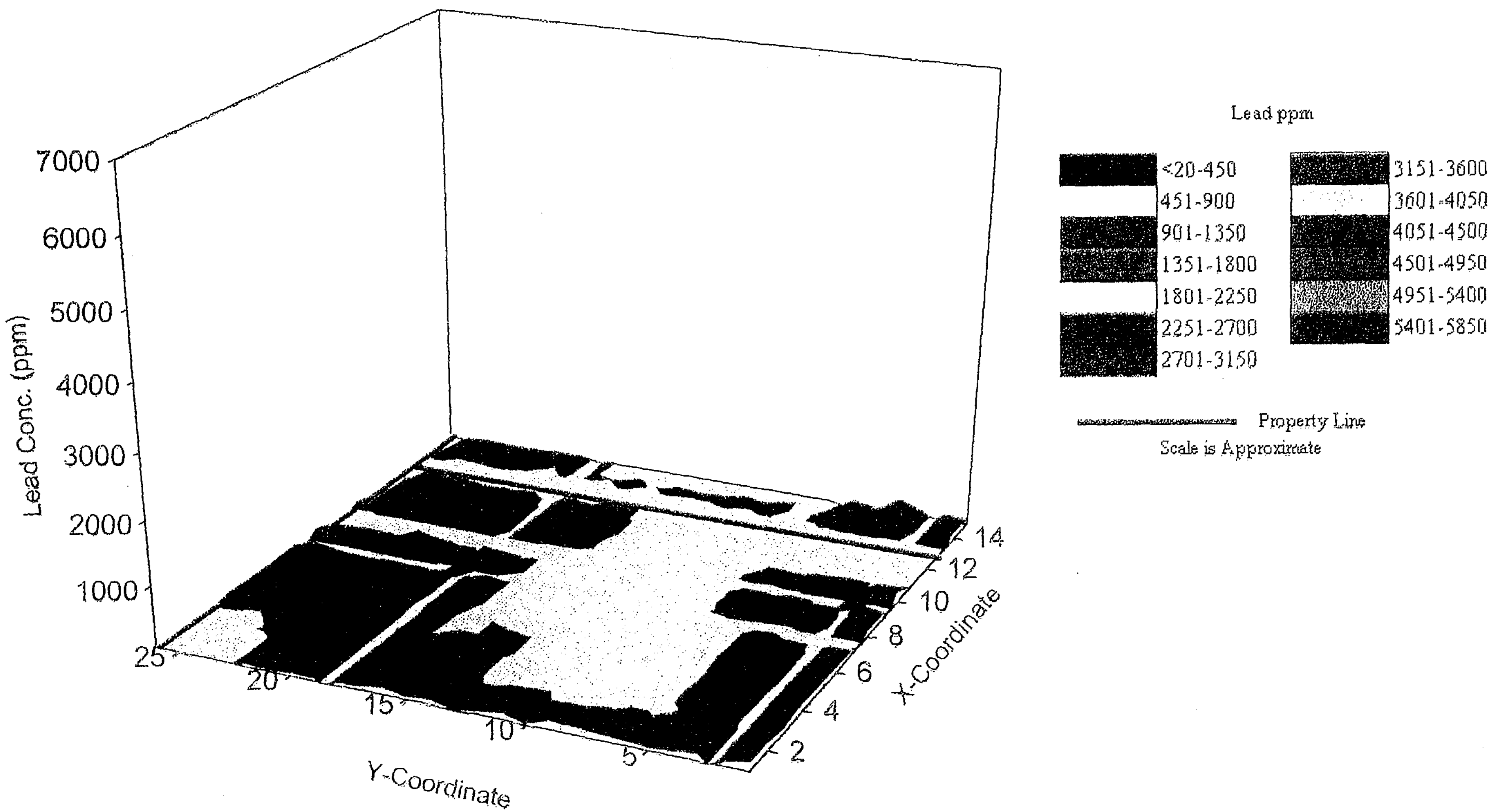


Lead Concentrations - Location 5



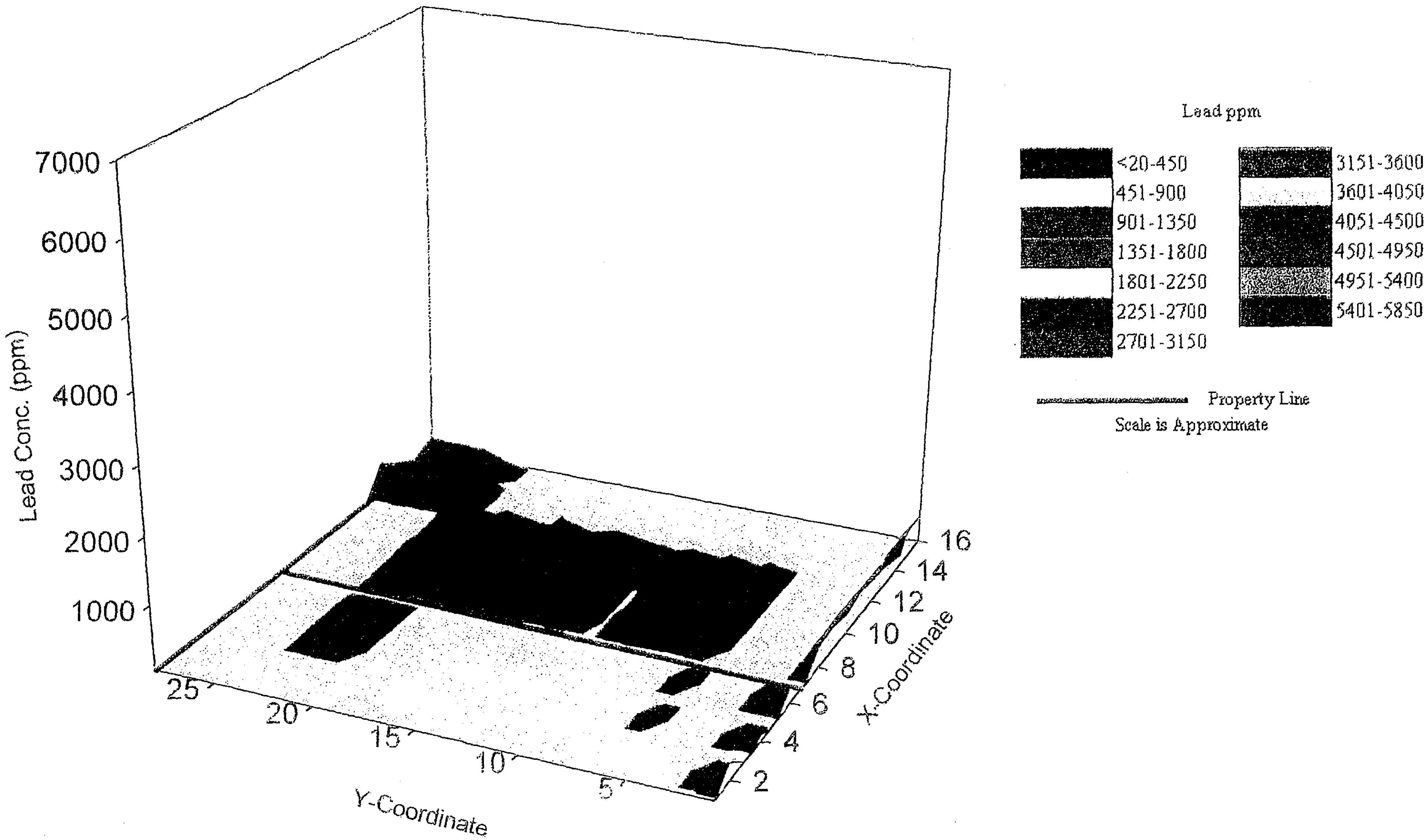
F2-5

Lead Concentrations - Location 6



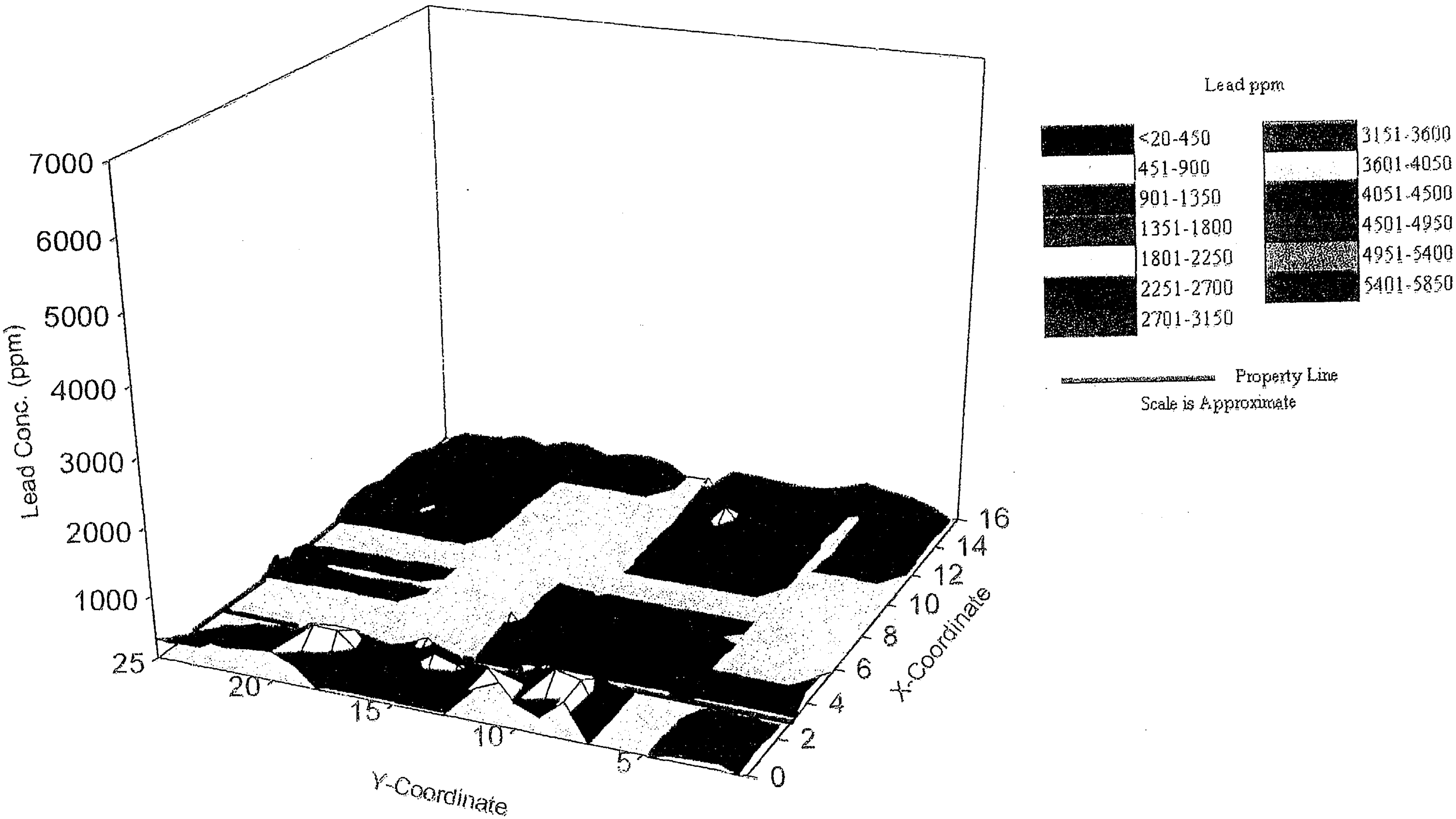
F2-6

Lead Concentrations - Location 7



F2-7

Lead Concentrations - Location 8



APPENDIX F3

Sample Locations and Concentrations Above 6000 ppm

SAMPLE LOCATIONS AND CONCENTRATIONS ABOVE 6000 PPM

Location	X-Coord	Y-Coord	Arsenic Concentration (ppm)
2	15	5	6,139
	15	6	11,785
	20	6	6,841
	16	7	6,934
	1	9	7,810
	6	11	6,887
	6	11.5	11,742
	7	11.5	6,748
	1	12	6,374
5	14	4	13,171
	31	9.7	7,026
	13	10	7,165
	19	11	6,654
	20	11	11,657
	21	11	9,656
	22	11	11,913
	23	11	16,176
	25	11	6,701
	20	12	8,898
	23	12	7,165

APPENDIX G

Risk Based Sampling 2-D Contour Maps

APPENDIX G1

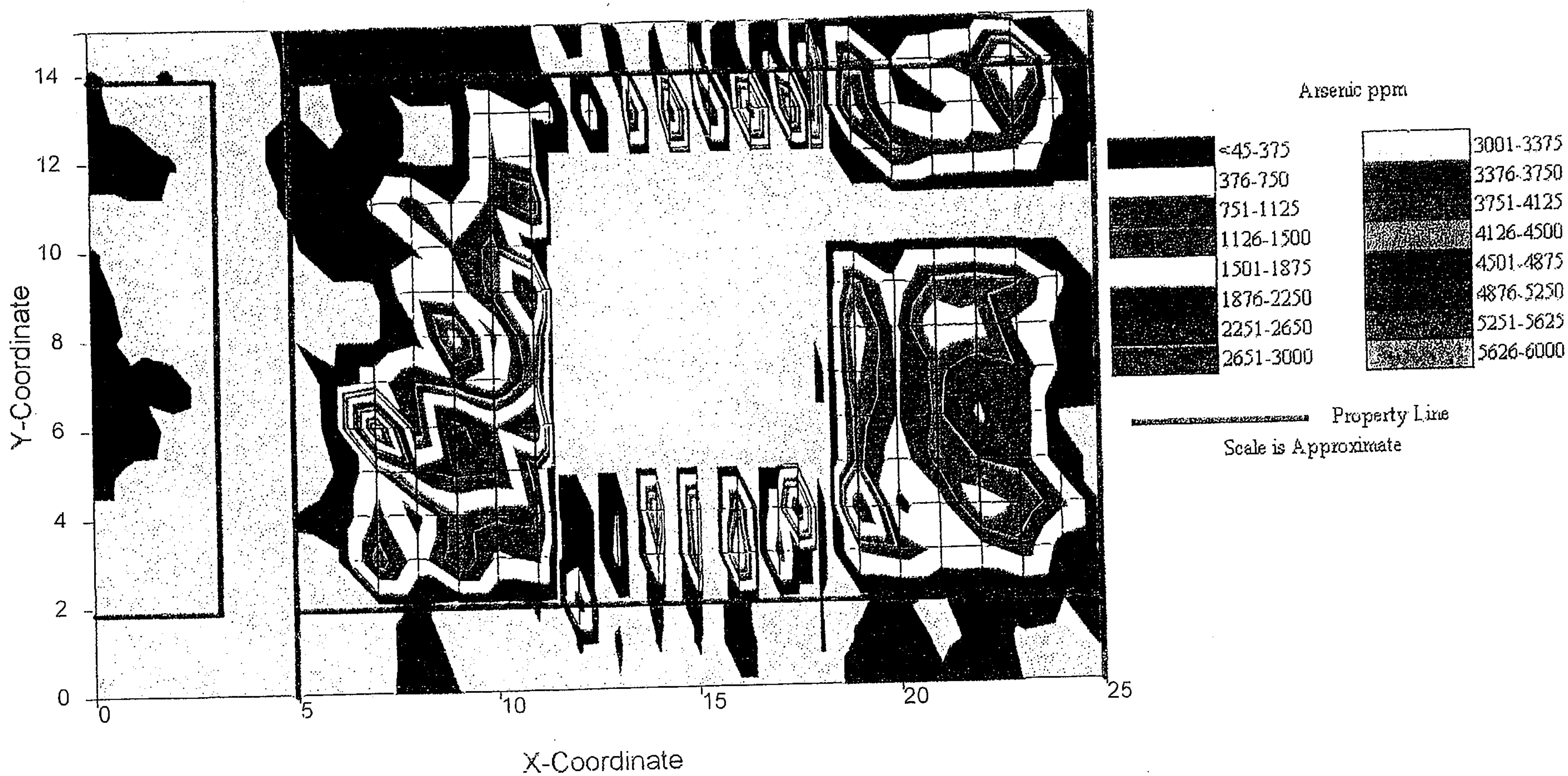
Distribution of Arsenic

Poor Quality Source Document

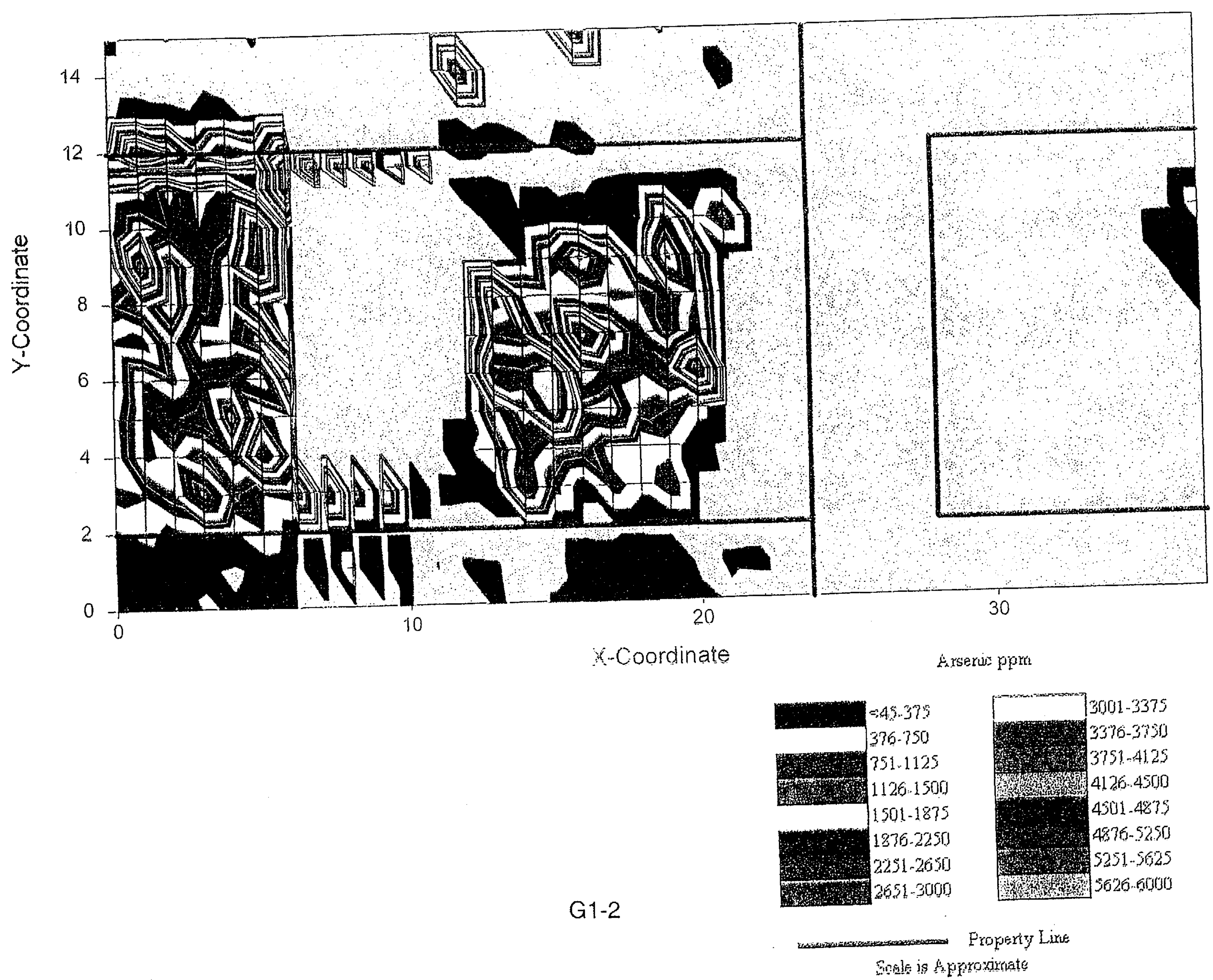
The following document images have been scanned from the best available source copy.

To view the actual hard copy, contact the Superfund Records Center at 303-312-6473

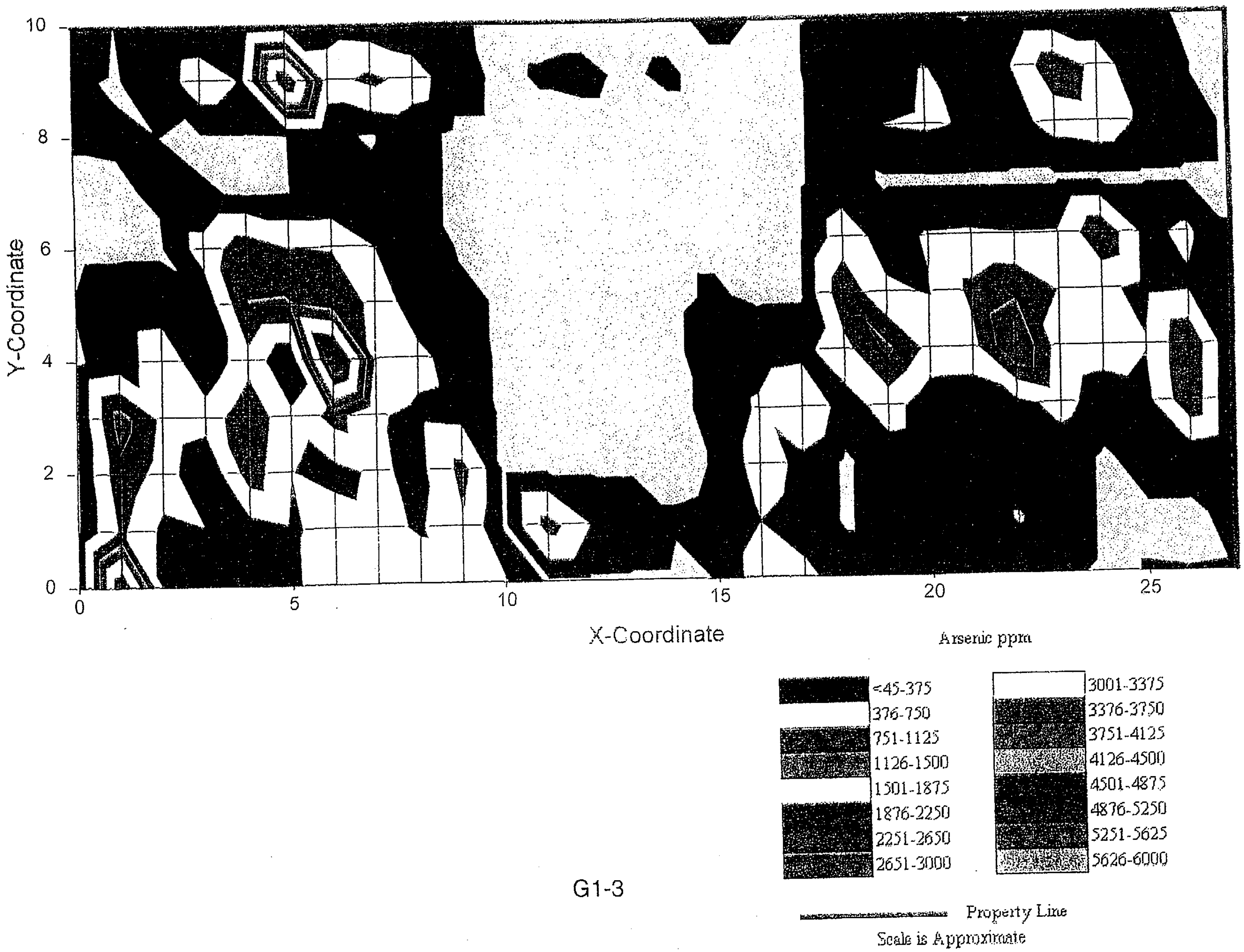
Distribution of Arsenic at Location 1



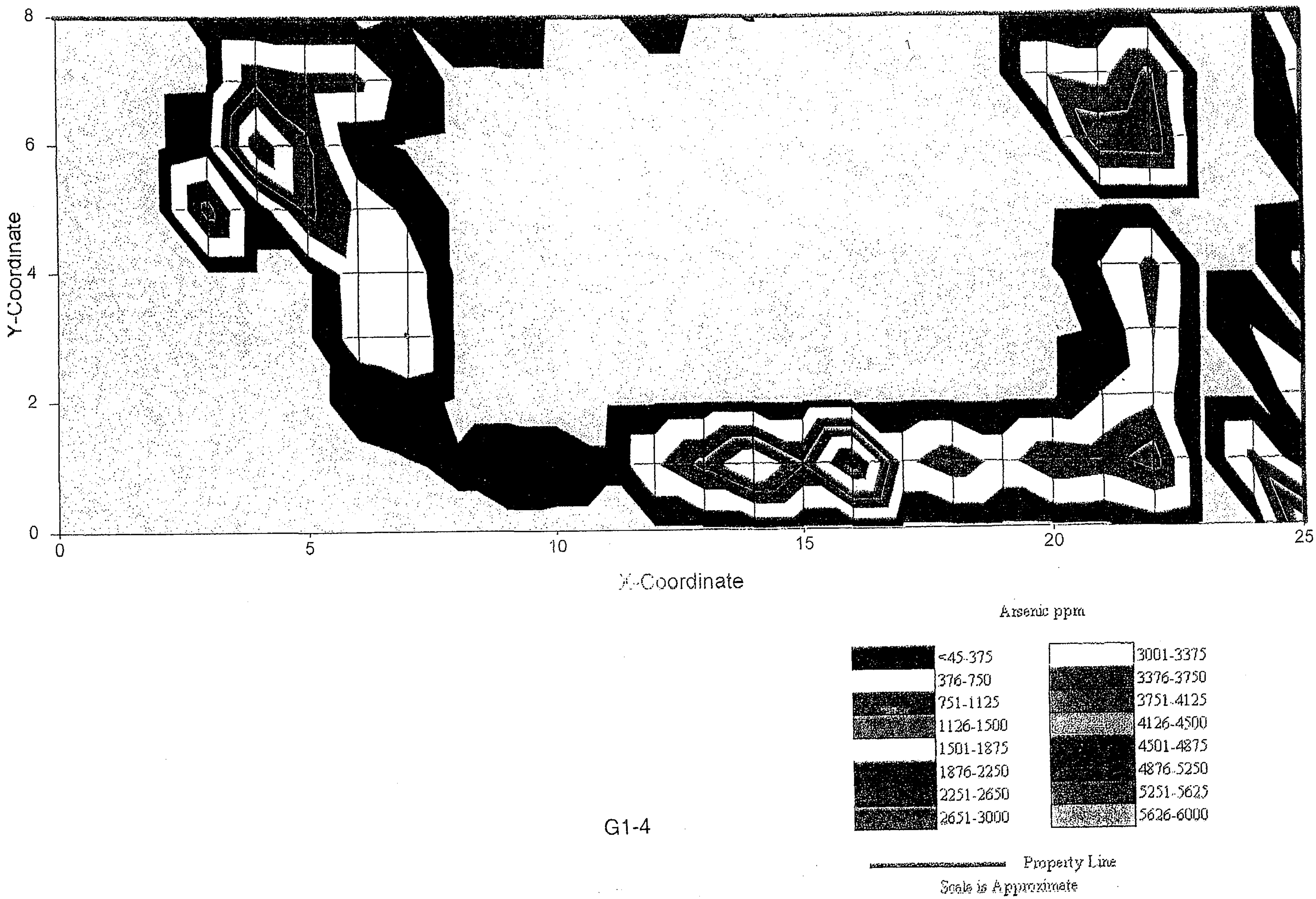
Distribution of Arsenic at Location 2



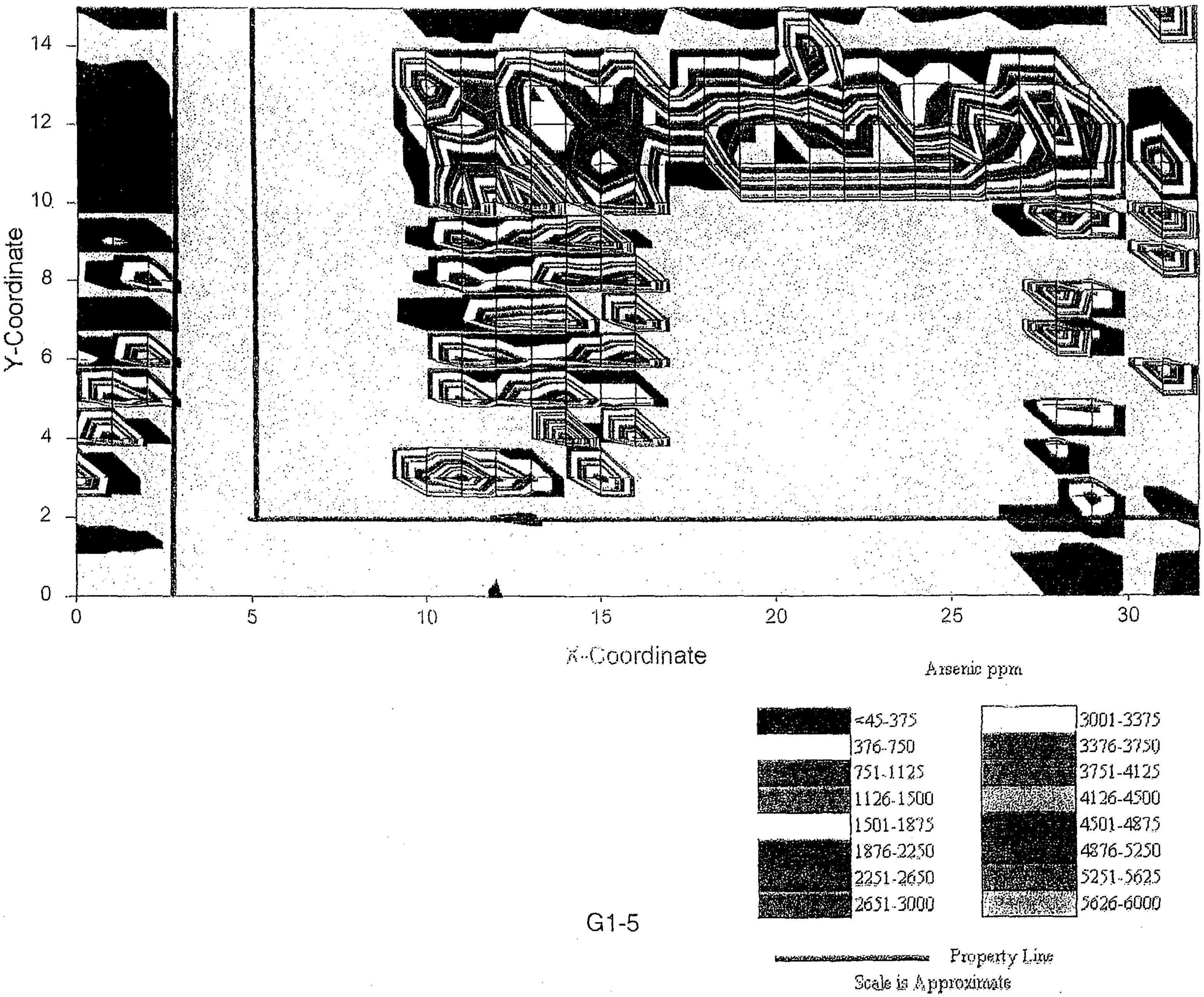
Distribution of Arsenic at Location 3



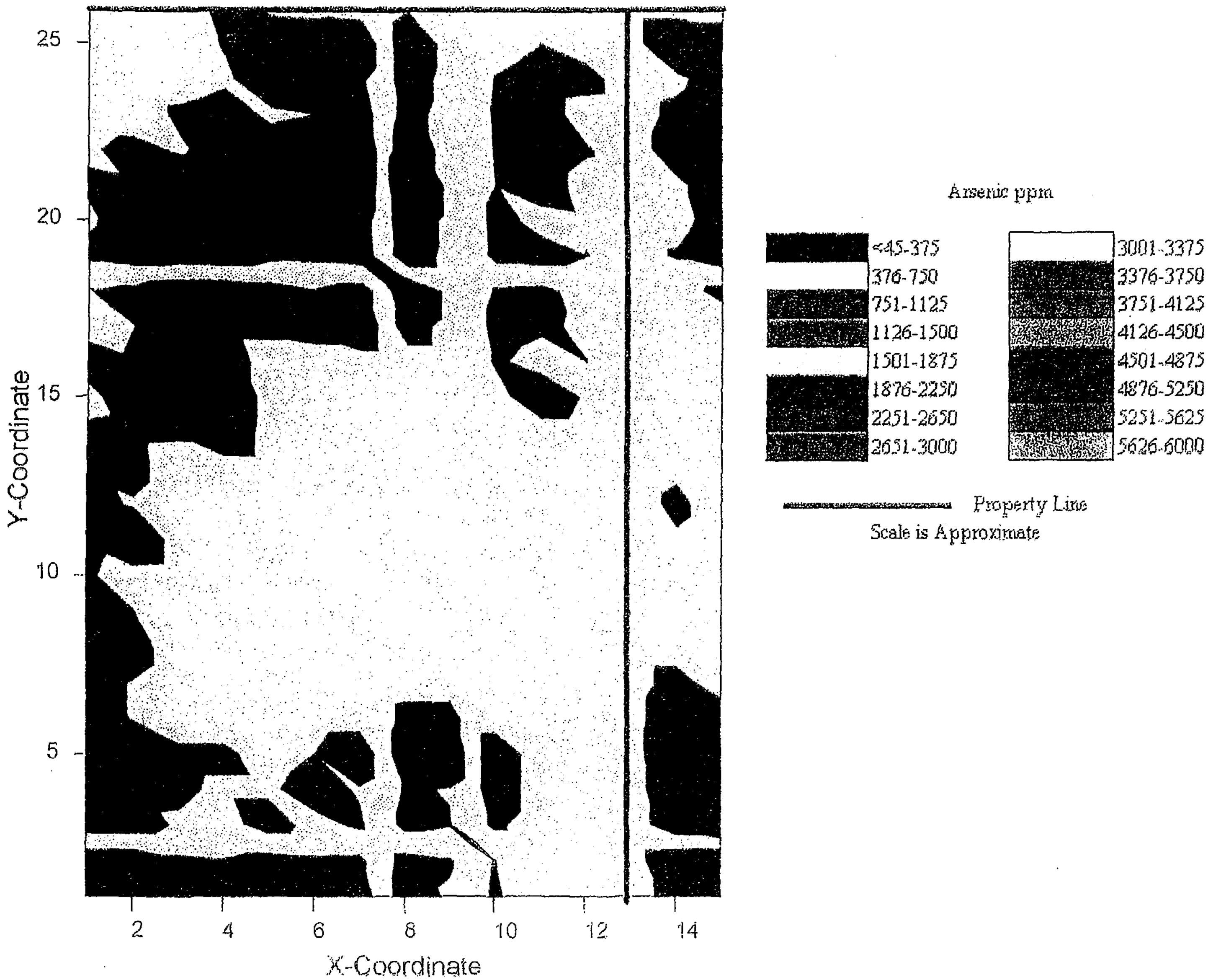
Distribution of Arsenic at Location 4



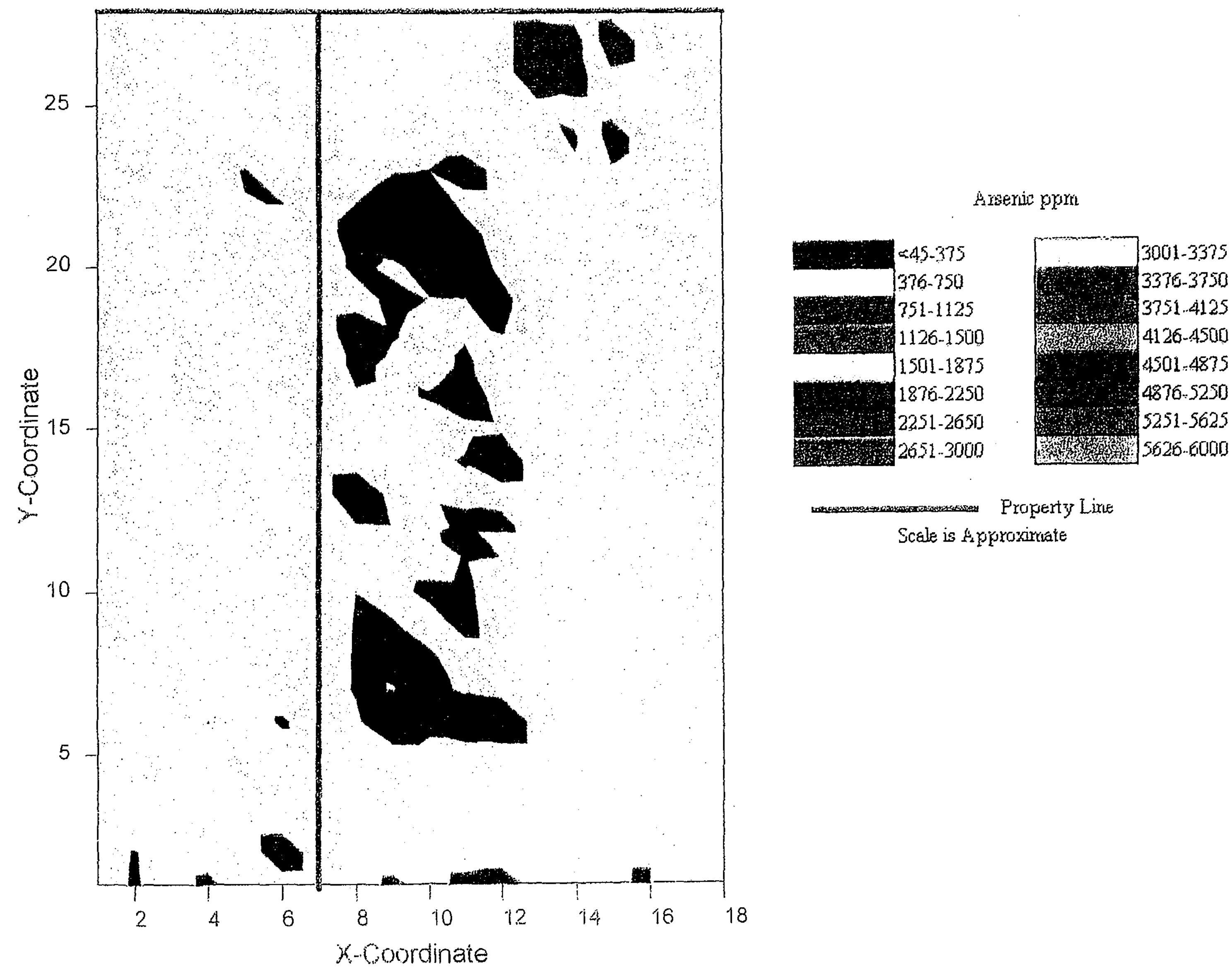
Distribution of Arsenic at Location 5



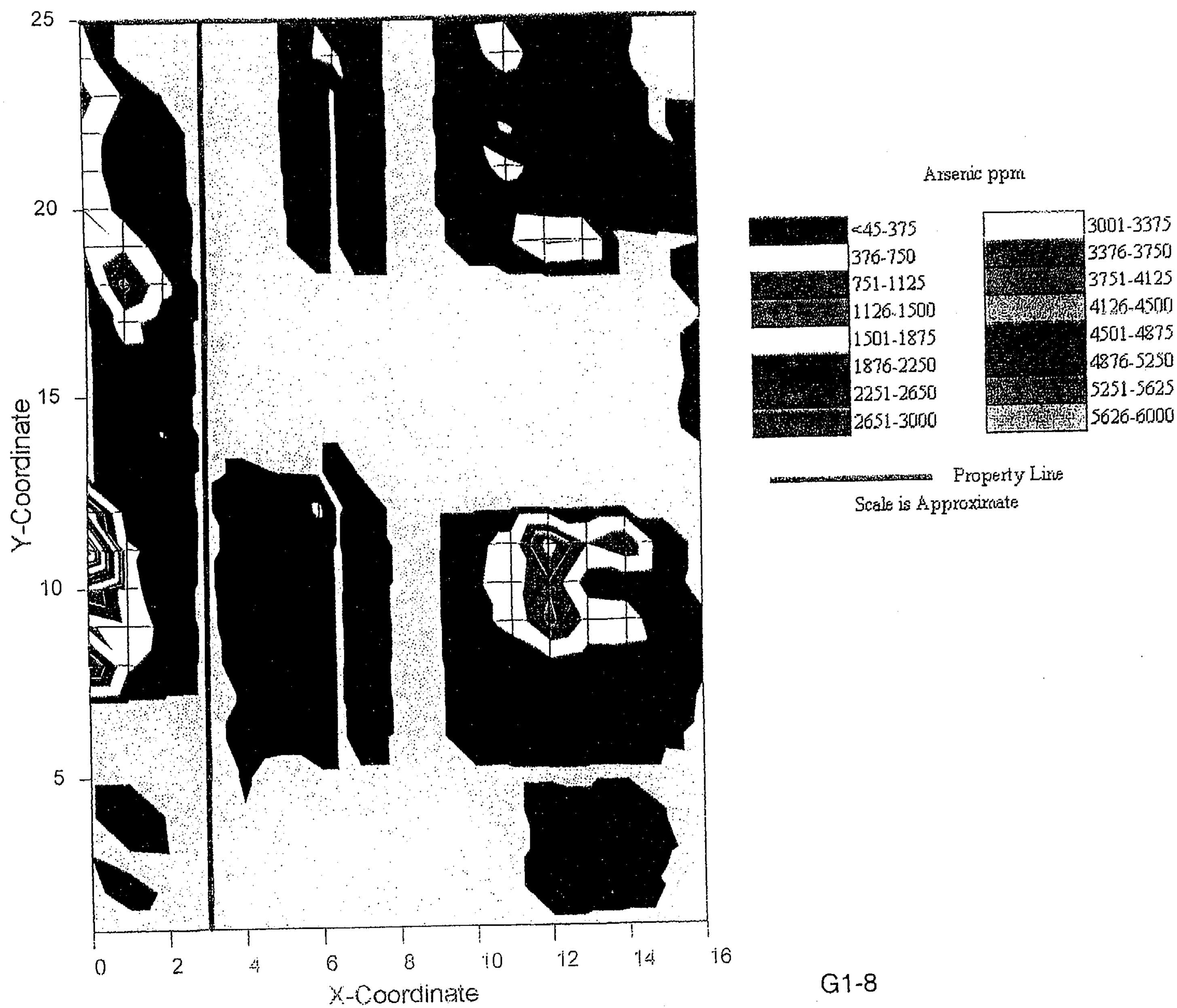
Distribution of Arsenic at Location 6



Distribution of Arsenic at Location 7



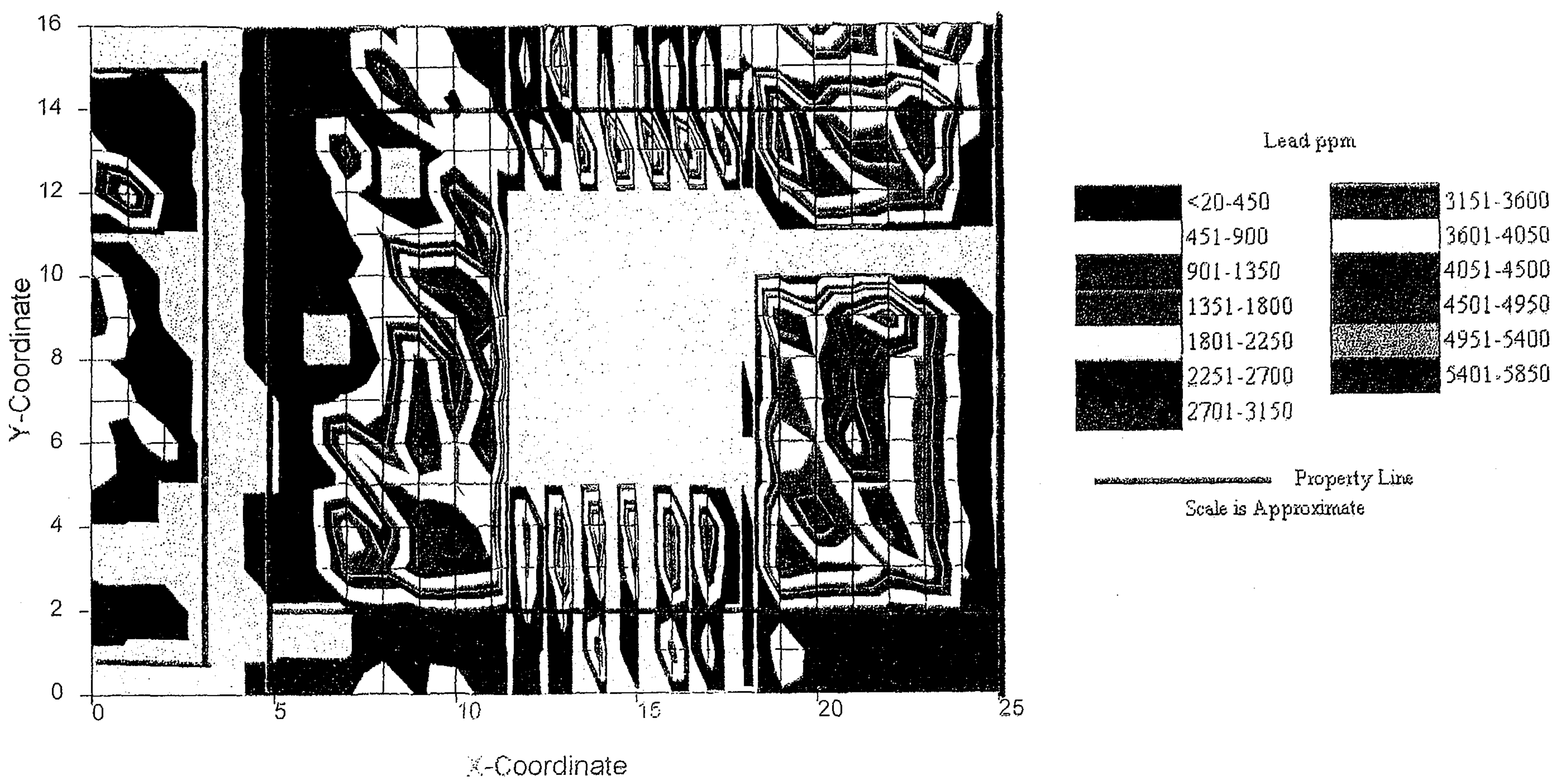
Distribution of Arsenic at Location 8



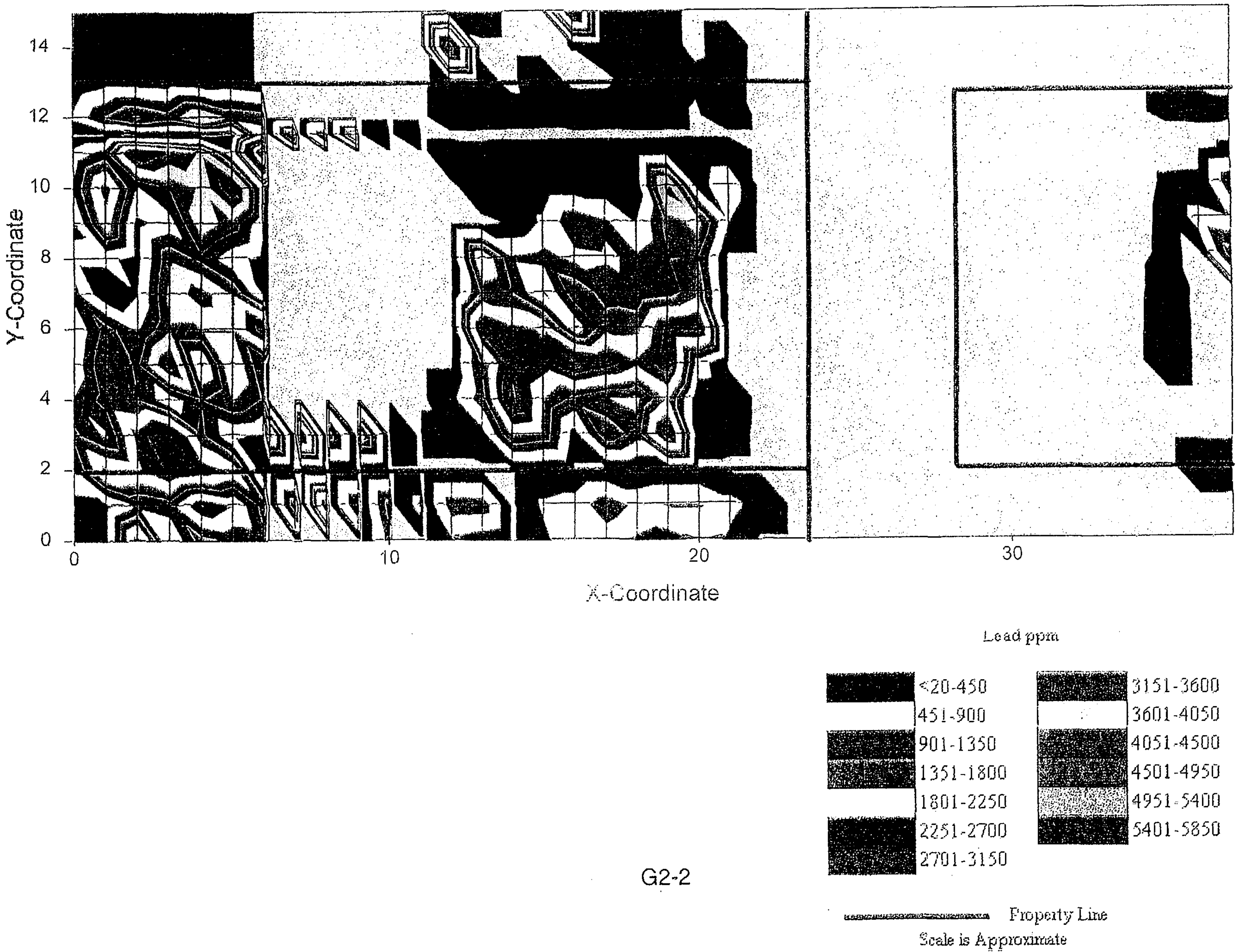
APPENDIX G2

Distribution of Lead

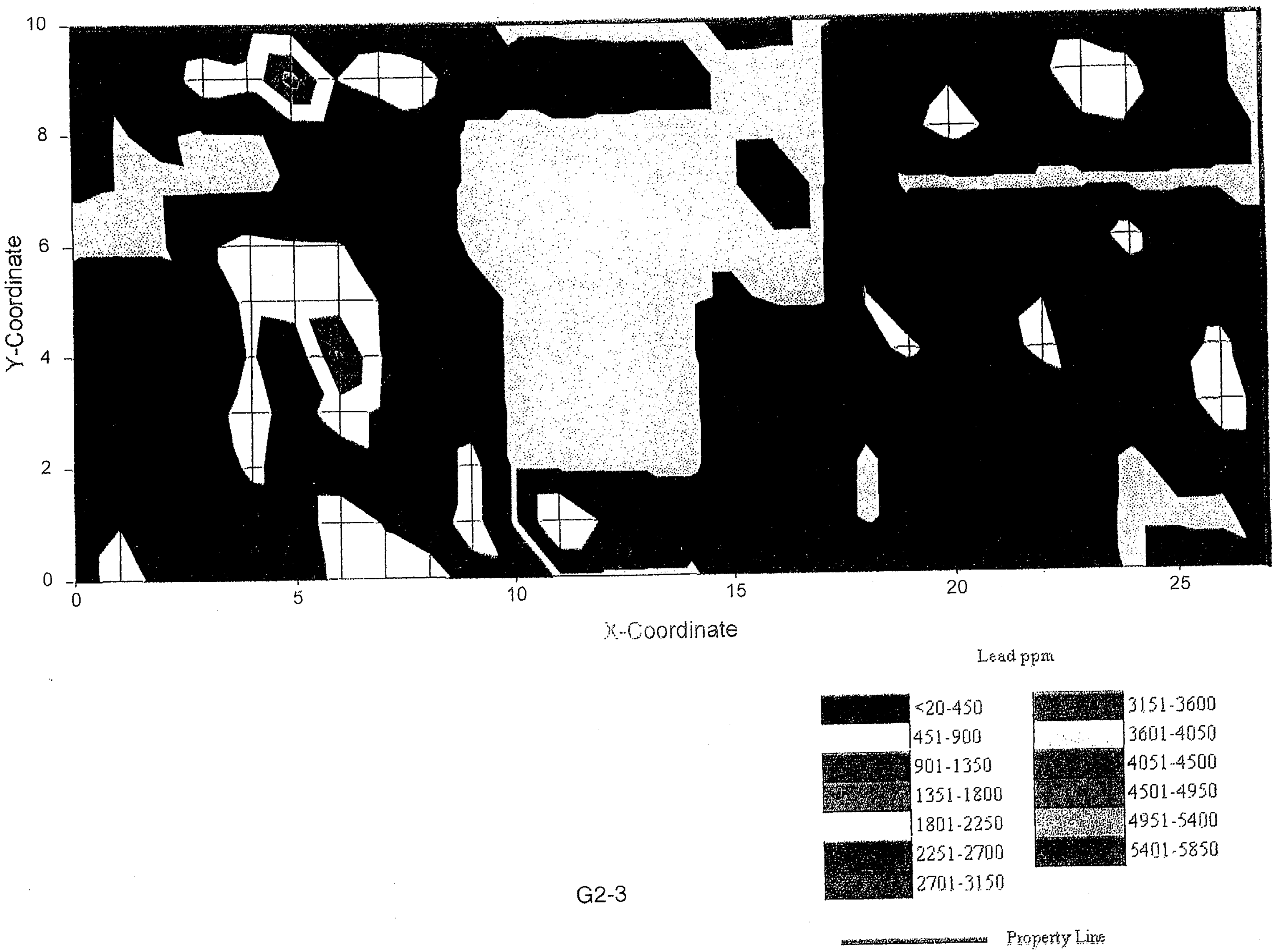
Distribution of Lead for Location 1



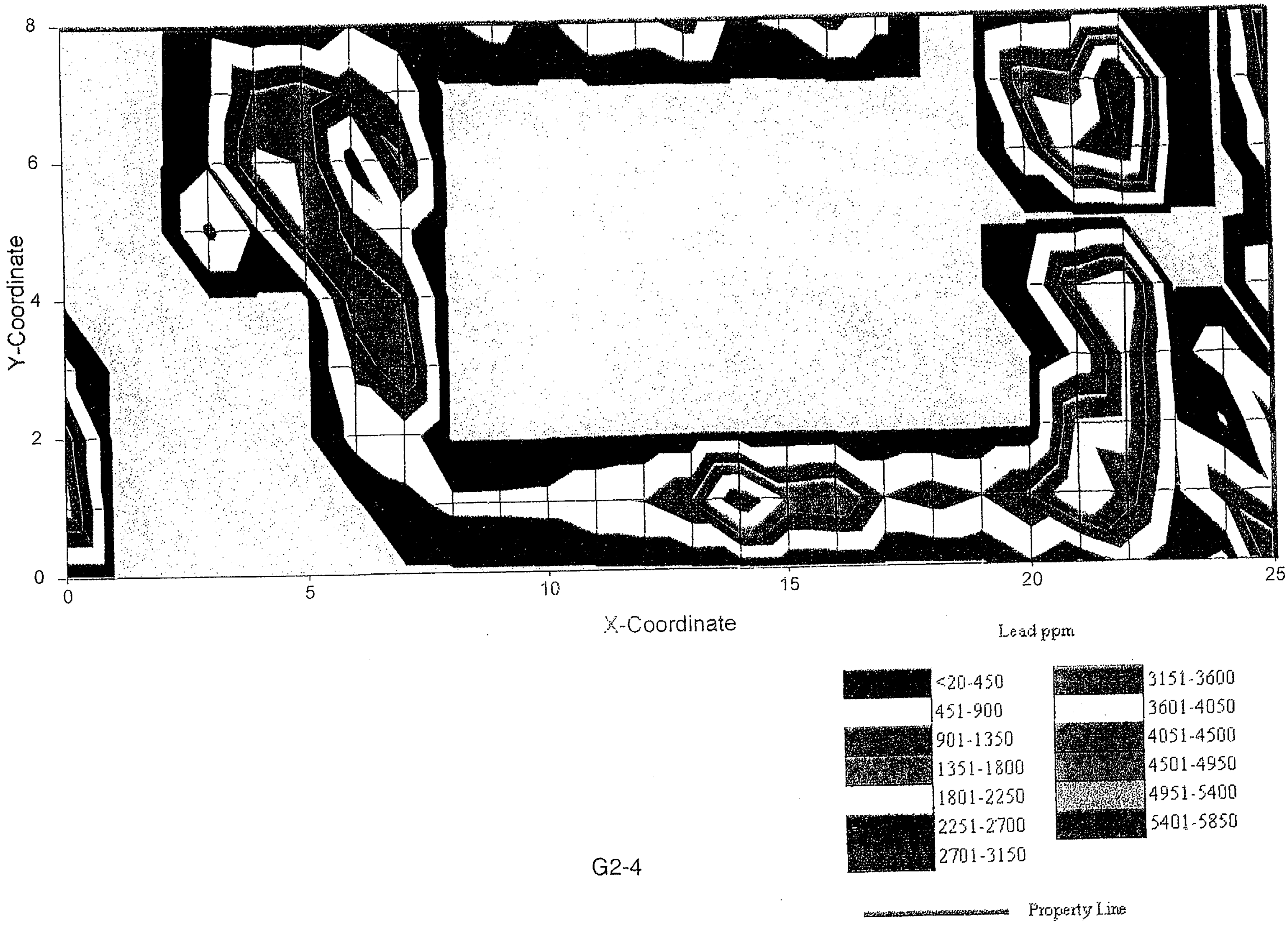
Distribution of Lead at Location 2



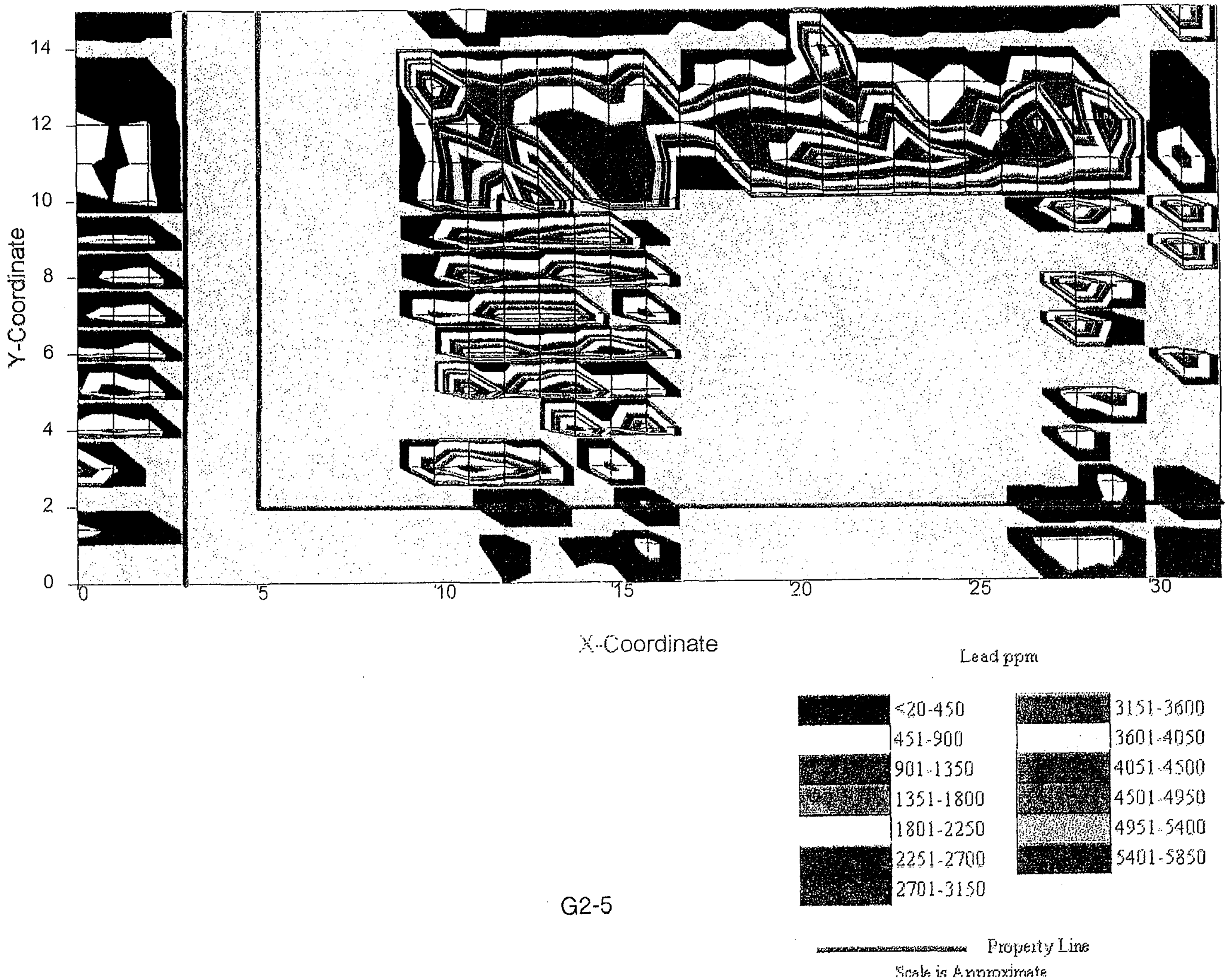
Distribution of Lead at Location 3



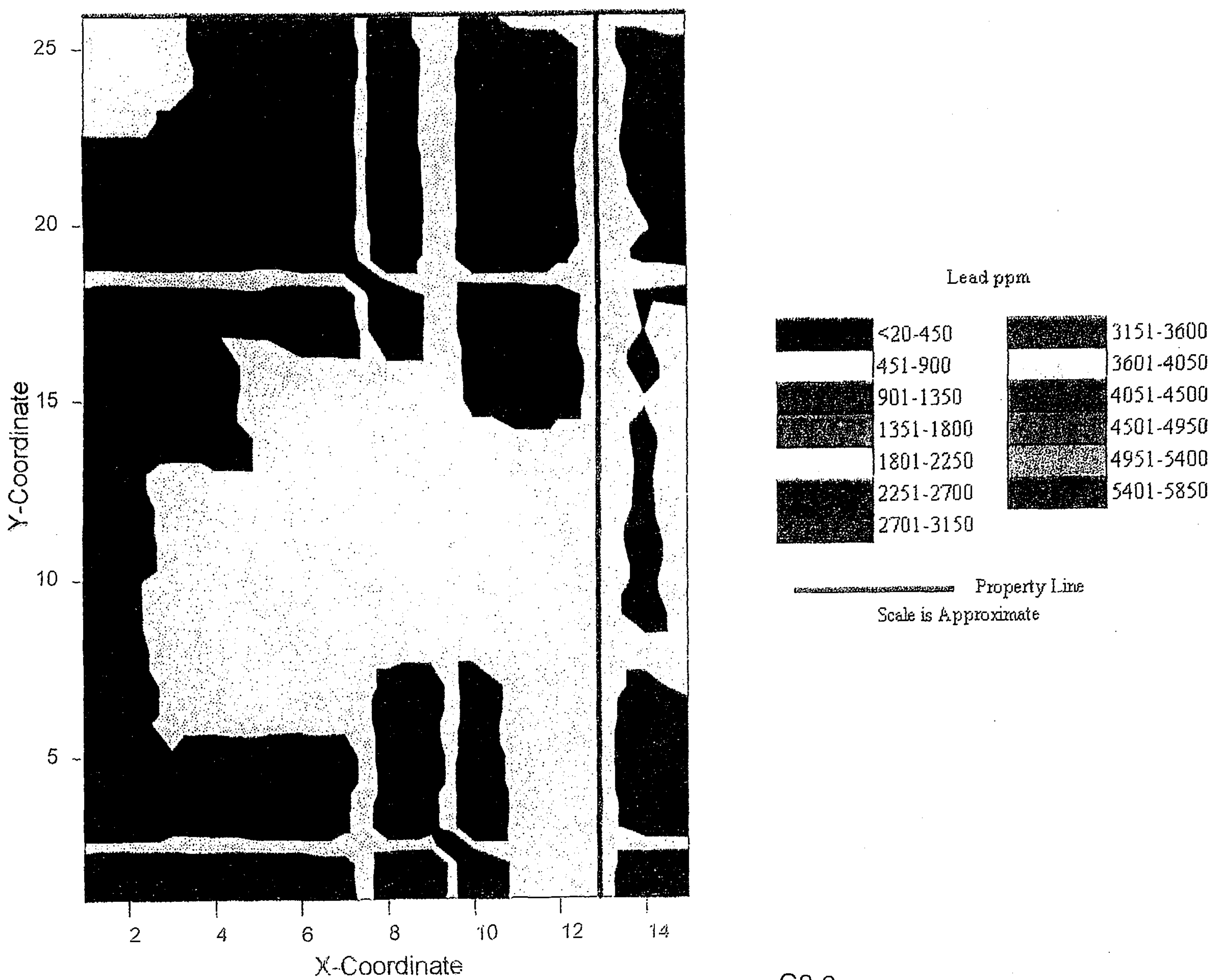
Distribution of Lead at Location 4



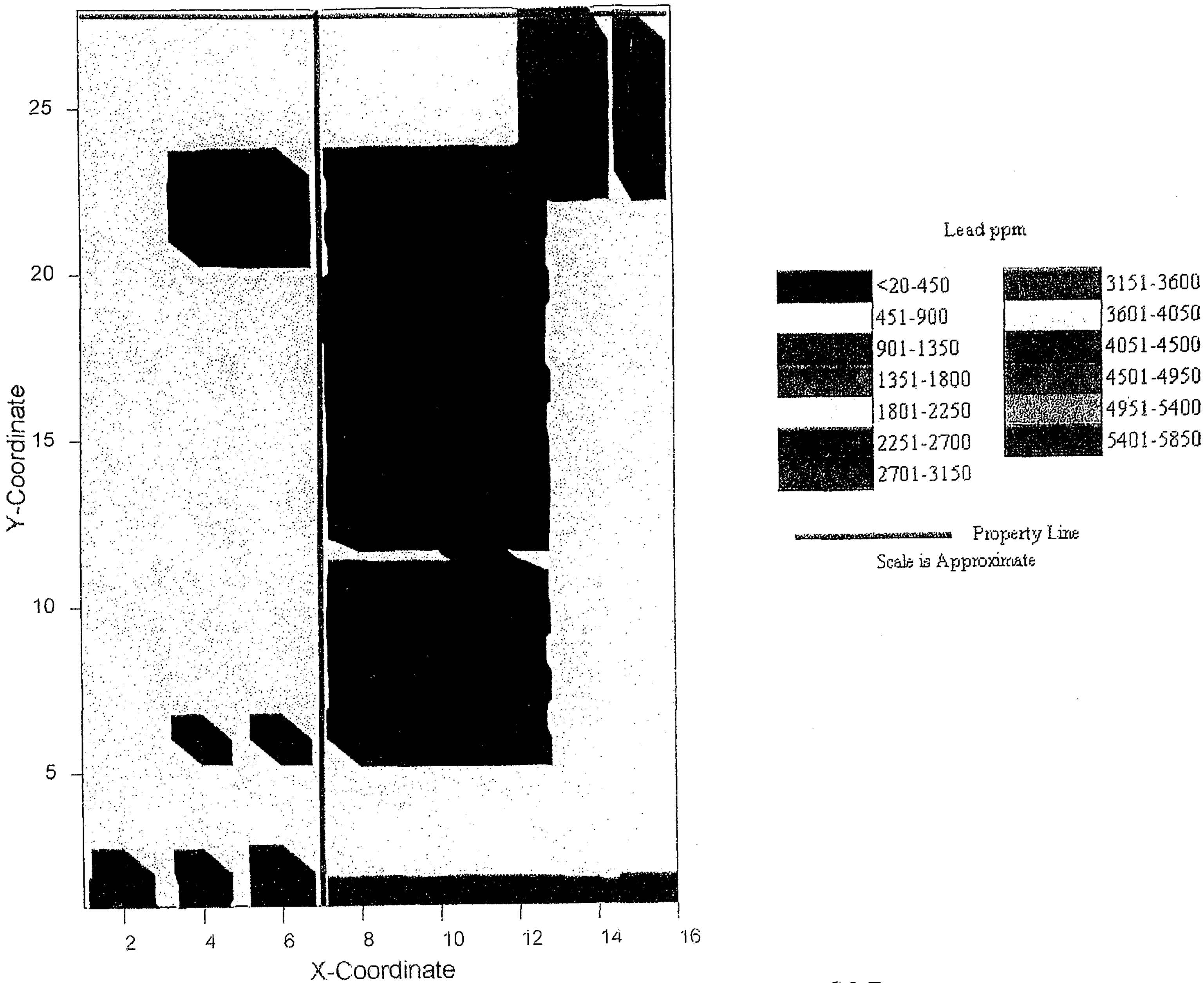
Distribution of Lead at Location 5



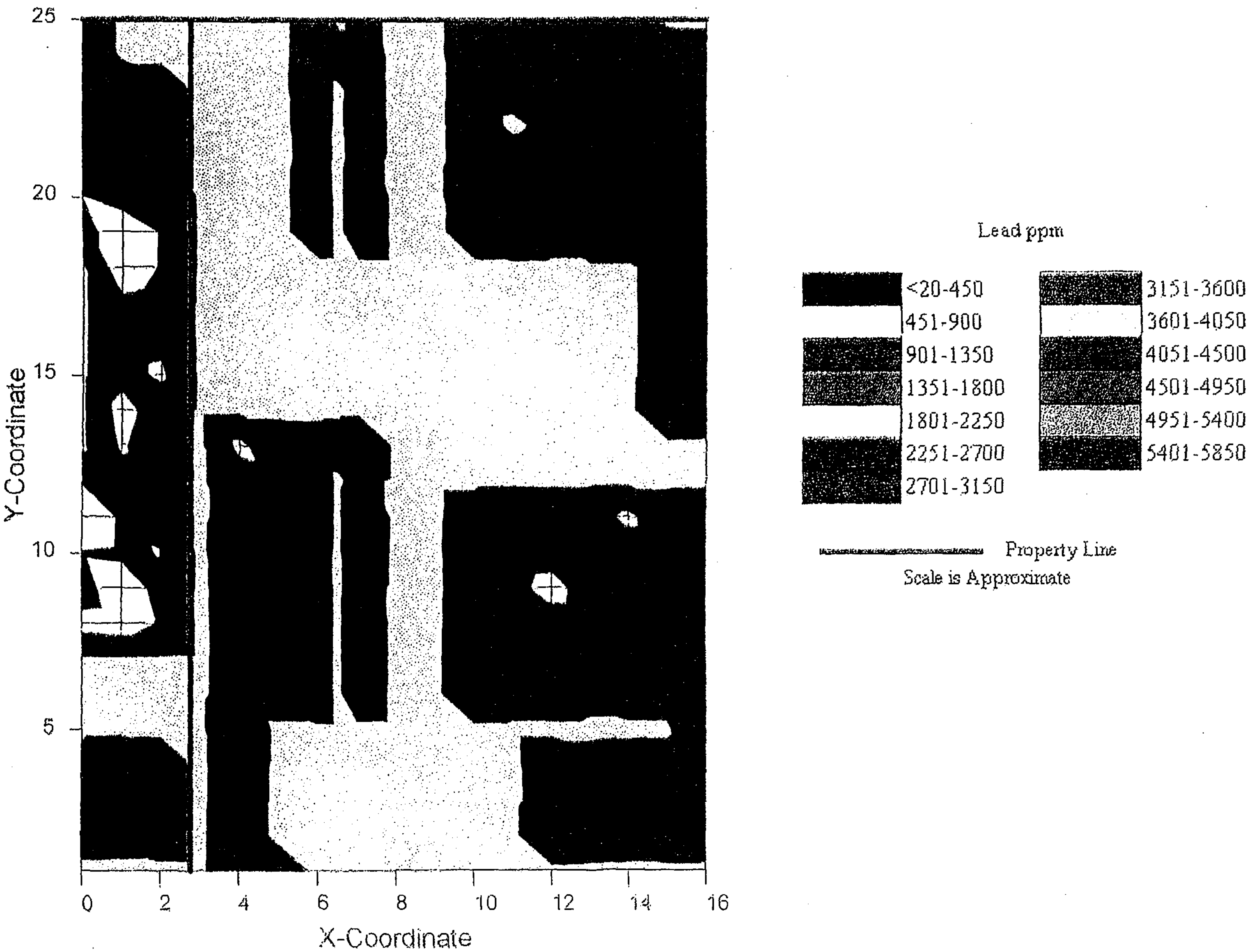
Distribution of Lead at Location 6



Distribution of Lead at Location 7



Distribution of Lead at Location 8



APPENDIX H

Risk Based Environmental and Biomonitoring Sample Results

APPENDIX H1

Analytical Results for Household and Attic Dust

ANALYTICAL RESULTS FOR HOUSEHOLD AND ATTIC DUST

Residence Code	Lab Number	Sample Type	ICP Concentration (ppm) Q	As	Cd	Pb	Zn	XRF Concentration (ppm) Q	As	Cd	Pb	Zn
A	ND-98-2826D	H		**IS**	**IS**	**IS**	**IS**		83	24	79	869
A	ND-98-2812D	A		53	71	1742	7218		499	67	2809	4538
B	ND-98-2825D	H	U	45	13	148	453		169	9	79	660
B	ND-98-2835D	A		**IS**	**IS**	**IS**	**IS**	U	45	32	828	4383
C	ND-98-2834D	H	U	45	21	343	753		77	24	230	955
C	NC	A		--	--	--	--		--	--	--	--
D	ND-98-2832D	H	U	45	18	151	254		130	7	116	318
D	ND-98-2804D	A	U	45	30	2900	689		53	7	4106	427
E	ND-98-2831D	H		**IS**	**IS**	**IS**	**IS**		116	18	76	648
E	ND-98-2813D	A	U	45	49	554	1076		85	36	563	1362
F	ND-98-2824D	H		**IS**	**IS**	**IS**	**IS**		70	24	220	610
F	ND-98-2820D	A	U	45	36	999	1080		**IS**	**IS**	**IS**	**IS**
G	ND-98-2821D	H		**IS**	**IS**	**IS**	**IS**		84	16	385	1645
G	ND-98-2814D	A		62	59	1507	3168		377	46	1946	3433
H	ND-98-2829D	H	U	45	12	121	391		51	14	67	517
H	NC	A		--	--	--	--		--	--	--	--
I	ND-98-2819D	H	U	45	12	402	1039		96	23	361	1308
I	ND-98-2816D	A	U	45	21	253	443		104	10	231	544
J	ND-98-2805D	H		**IS**	**IS**	**IS**	**IS**		126	16	100	1905
J	ND-98-2818D	A	U	45	173	399	2126	U	45	275	293	2777
K	ND-98-2815D	H		**IS**	**IS**	**IS**	**IS**		**IS**	**IS**	**IS**	**IS**
K	ND-98-2817D	B		62	29	673	6116		78	27	811	6865
L	ND-98-2837D	H	U	45	5	421	590		123	14	310	982
L	ND-98-2836D	B	U	45	27	1276	4816		47	35	1698	5197
M	ND-98-2827D	H	U	45	18	336	690	U	45	6	222	734
M	ND-98-2833D	H		**IS**	**IS**	**IS**	**IS**		**IS**	**IS**	**IS**	**IS**
N	ND-98-2823D	H		**IS**	**IS**	**IS**	**IS**		97	12	158	846
N	ND-98-2822D	A		**IS**	**IS**	**IS**	**IS**		**IS**	**IS**	**IS**	**IS**
O	ND-98-2807D	H	U	45	44	625	1121		164	39	1145	2002
O	ND-98-2808D	A		**IS**	**IS**	**IS**	**IS**		422	15	916	1459
P	ND-98-2828D	H		**IS**	**IS**	**IS**	**IS**		172	19	99	761
P	ND-98-2830D	A	U	45	27	890	3194		70	12	1037	2529
--	ND-98-2806D	QC		441	54	3683	7163		719	30	5507	5973
--	ND-98-2809D	QC		558	66	3697	7035		821	36	5583	5895
--	ND-98-2810D	QC		89	170	979	383		65	35	1115	334
--	ND-98-2811D	QC		96	75	950	383		131	52	1464	328

-- Not Applicable
A - Attic Dust
H - Household Dust
B - Basement Dust
QC - Blind Quality Control Sample (NIST Standard #2711)
IS - Insufficient sample available for collection
NC - Not Collected

APPENDIX H2

Analytical Results for Residential Tap Water Samples

ANALYTICAL RESULTS FOR RESIDENTIAL TAP WATER SAMPLES

Residence Code	Lead (µg/L)			
	Q	First Flush	Q	Post Flush
A	U	3		4.3
B	U	3	U	3
C		--		--
D	U	3	U	3
E	U	3	U	3
F		3.1	U	3
G		5.4		5.9
H	U	3	U	3
I		11.4		6.0
J	U	3	U	3
K	U	3	U	3
L		--		--
M		--		--
N		3.1	U	3
O		4.5	U	3

U - Not detected
-- Not Collected

APPENDIX H3

Lead Paint Measured in Removal Properties

LEAD PAINT MEASURED IN REMOVAL PROPERTIES

Residence Code	Interior/ Exterior	Room	Sample ID	Sample Location	Result (mg Pb/cm2)	Paint Condition	Comments
A	I	Kitchen		South Wall	2.9	1	
	E	--		Soffit	6.9	1	
				Door Frame	4.8	1	
B	E	--	5	Window Sill	0.4	1	
			10	Window Sill	0.4	1	
C	I	Living Room	1	Door Frame	11.4	1	
			2	Exterior Door	5.9	1	
			6	Window Sash	0.9	2	
			7	Window Well	3.1	2	
		Bedroom	2	Door	11.1	1	
	E	--	1	Support Column	13.2	1	
			2	Porch Ceiling	12.2	1	
			3	Window Casing	2.4	1	
D	I	Living Room	1	Door Frame	1.1	1	
	E	--	1	Soffit	1.1	1	
E	I	Living Room	1	Door Jamb	1.2	1	
		Kitchen	3	Door Frame	1.5	1	
		Bedroom	5	Baseboard	0.4	1	
	E	--	1	Door Frame	4.9	1	
			3	Downspout	4.0	2	
			5	Roof Trim	1.6	1	
			6	Fascia	4.1	1	
			7	Soffit	3.3	2	
			9	Window Mullion	2.4	1	
			10	Porch Ceiling	1.6	3	
F	I	Living Room	1	Door Frame	1.7	1	
			2	Exterior Door	1.1	1	
			3	Threshold	1.7	1	
			4	Door Casing	1.1	1	
			5	Window Sill	2.6	1	
			6	Window Casing	0.8	1	
			7	Baseboard	0.8	1	
		Bedroom	1	Door Frame	1.4	1	
			3	Window Sill	0.4	1	
			4	Window Sash	5.6	1	
			5	Door Casing	1.0	1	
			7	Threshold	1.9	3	
		Kitchen	1	Door Frame	2.4	1	
			2	Door	2.3	1	
			3	Door Casing	1.0	1	
			5	Window Sill	1.5	1	
	E	--	2	Window Casing	3.8	3	
			3	Window Casing	3.8	1	
			4	Window Sill	3.6	2	
			5	Support Column	4.8	2	

Residence Code	Interior/ Exterior	Room	Sample ID	Sample Location	Result (mg Pb/cm2)	Paint Condition	Comments
F	E	--	6	Porch Ceiling	2.5	2	
			7	Window Casing	4.4	1	
			8	Window Sill	6.1	1	
			9	Shutter	7.2	1	
G	I	Living Room	1	Door Frame	1.2	1	
	E	--	2	Porch Ceiling	1.6	2	
			3	Support Column	1.8	3	
H	E	--	1	Ext. Wall Siding	5.7	3	(being covered)
I	I	Living Room	1	Door Frame	16.1	1	
			2	Door Jamb	0.8	1	
			6	Top Drawer	2.8	1	
			8	Window Well	0.5	3	
			9	Window Jamb	3.0	1	
			11	Baseboard	0.3	1	
		Kitchen	1	Door Frame	1.6	2	
			2	Door Casing	1.9	1	
			3	Door Casing	1.9	1	
			4	Door Frame	1.9	1	
			5	Wall	14.8	1	
			6	Door	4.1	1	
			8	Wall	19.0	1	
			9	Window Sill	4.5	1	
			10	Window Sash	6.1	1	
	E	--	1	Porch Ceiling	5.5	1	
			2	Beam	13.9	1	
			3	Soffit	13.2	1	
			4	Window Sash	7.9	1	
			5	Ext. Wall Siding	7.8	1	
			7	Window Sash	1.9	1	
			8	Corner Board	14.4	3	
			9	Lap Siding	8.8	2	
			11	Window Casing	12.2	2	
J	I	Living Room	1	Door Frame	1.7	1	
			2	Door Jamb	2.5	1	
		Kitchen	4	Door Frame	1.3	1	
	E	--	1	Gutter	1.4	1	
K	I	Bedroom	1	Door	0.4	1	
	E	--	1	Beam	1.0	1	
			2	Support Column	2.0	1	
			3	Window Trim	10.5	1	

Residence Code	Interior/ Exterior	Room	Sample ID	Sample Location	Result (mg Pb/cm2)	Paint Condition	Comments
L	I	Living Room	1	Door Frame	4.9	1	
			2	Door Jamb	3.5	1	
			3	Door Casing	8.3	1	
			4	Wall	3.6	1	
			5	Door Frame	9.2	1	
			7	Window Sill	8.2	1	
			9	Baseboard	13.4	1	
		Bedroom	1	Transom	11.6	1	
			2	Door Casing	8.4	1	
			4	Door	10.8	1	
			5	Baseboard	18.3	1	
			6	Wall	7.8	1	
			7	Window Well	18.2	1	
			8	Wall	3.9	1	
		Kitchen	1	Door Frame	9.8	1	
			2	Door Casing	8.1	1	
			4	Door Frame	4.8	1	
			5	Door Casing	6.1	1	
			7	Window Sill	5.0	1	
			8	Door	8.1	1	
	E	--	2	Window Sill	6.5	1	
			4	Window Sill	6.5	1	
			7	Wall Stripe	2.5	1	
M	I	Kitchen	3	Window Casing	2.4	1	
			4	Door Casing	2.1	1	
			5	Door	1.2	1	
			6	Baseboard	1.9	1	
		Living Room	1	Door Frame	1.3	1	
			2	Door Casing	0.8	1	
			5	Window Sill	1.4	1	
		Bedroom	1	Door	2.0	1	
			2	Door Casing	3.1	1	
			5	Window Sill	1.5	1	
	E	--	1	Fascia	2.4	3	
			2	Support Column	5.5	2	
			3	Threshold	1.9	1	
			4	Ext. Door	1.3	1	
N	E	--	.4	Window Casing	3.3	1	

Residence Code	Interior/ Exterior	Room	Sample ID	Sample Location	Result (mg Pb/cm2)	Paint Condition	Comments
O	I	Kitchen	1	Door	2.5	1	
			2	Door Frame	1.6	1	
			3	Door	2.1	1	
			4	Wall	1.4	1	
		Living Room	1	Door Frame	2.1	1	
			2	Threshold	3.6	2	
			3	Door Casing	1.7	1	
		Bedroom	1	Door Frame	1.6	1	
			2	Door Jamb	2.3	1	
			3	Door Casing	2.0	1	
			5	Window Sill	1.5	2	
			6	Window Well	7.2	2	
	E	--	1	Window Sill	7.5	2	
			2	Door Casing	2.7	1	
			5	Corner Board	5.7	2	
			6	Door Casing	3.9	1	
			7	Door	0.5	2	
			9	Fencepost	1.7	3	
P	I	Living Room	1	Door Frame	0.7	1	
	E	--	1	Porch Ceiling	2.2	2	
			3	Door Frame	1.4	1	

APPENDIX H4

Summary Statistics for Lead Paint Measured On Removal Properties

Summary Statistics for Lead Paint Measured on Removal Properties

Location	Stats	Concentration (mg Pb/cm2)			
		Total	<1	1-5	>5
Total Property	N	144.0	14	87.0	43.0
	Minimum	0.3	0.3	1.0	5.5
	Maximum	19.0	0.9	5.0	19.0
	Mean	4.4	0.6	2.4	9.8
Interior	N	89.0	11	55.0	23.0
	Minimum	0.3	0.3	1.0	5.6
	Maximum	19.0	0.9	5.0	19.0
	Mean	4.2	0.6	2.2	10.6
Exterior	N	55.0	3	32.0	20.0
	Minimum	0.4	0.4	1.0	5.5
	Maximum	14.4	0.5	4.9	14.4
	Mean	4.8	0.4	2.7	8.9

APPENDIX H5

Summary Statistics for Lead Paint By Removal Property

Summary Statistics for Lead Paint
By Removal Property

Location	Stats	Concentration (mg Pb/cm2) Total	<1	1-5	>5
A	N	3.0	N/A	2.0	1.0
	Minimum	2.9	N/A	2.9	6.9
	Maximum	6.9	N/A	4.8	6.9
	Mean	4.9	N/A	3.9	6.9
B	N	2.0	2	N/A	N/A
	Minimum	0.4	0.4	N/A	N/A
	Maximum	0.4	4	N/A	N/A
	Mean	0.4	0.4	N/A	N/A
C	N	8.0	1	2.0	5.0
	Minimum	0.9	0.9	2.4	5.9
	Maximum	13.2	0.9	3.1	13.2
	Mean	7.5	0.9	2.8	10.8
D	N	2.0	N/A	2.0	N/A
	Minimum	1.1	N/A	1.1	N/A
	Maximum	1.1	N/A	1.1	N/A
	Mean	1.1	N/A	1.1	N/A
E	N	10.0	1	9.0	N/A
	Minimum	0.4	0.4	1.2	N/A
	Maximum	4.9	0.4	4.9	N/A
	Mean	2.5	0.4	2.7	N/A
F	N	24.0	3	18.0	3.0
	Minimum	0.4	0.4	1.0	5.6
	Maximum	7.2	0.8	4.8	7.2
	Mean	2.6	0.7	2.4	6.3
G	N	3.0	N/A	3.0	N/A
	Minimum	1.2	N/A	1.2	N/A
	Maximum	1.8	N/A	1.8	N/A
	Mean	1.5	N/A	1.5	N/A
H	N	1.0	N/A	N/A	1.0
	Minimum	5.7	N/A	N/A	5.7
	Maximum	5.7	N/A	N/A	5.7
	Mean	5.7	N/A	N/A	5.7
I	N	24.0	3	9.0	12.0
	Minimum	0.3	0.3	1.6	5.5
	Maximum	19.0	0.8	4.5	19.0
	Mean	6.9	0.5	2.6	11.6
J	N	4.0	N/A	4.0	N/A
	Minimum	1.3	N/A	1.3	N/A
	Maximum	2.5	N/A	2.5	N/A
	Mean	1.7	N/A	1.7	N/A
K	N	4.0	1	2.0	1.0
	Minimum	0.4	0.4	1.0	10.5
	Maximum	10.5	0.4	2.0	10.5
	Mean	3.5	0.4	1.5	10.5
L	N	23.0	N/A	7.0	16.0
	Minimum	2.5	N/A	2.5	6.1
	Maximum	18.3	N/A	5.0	18.3
	Mean	8.2	N/A	4.0	10.0
M	N	14.0	1	12.0	1.0
	Minimum	0.8	0.8	1.2	5.5
	Maximum	5.5	0.8	3.1	5.5
	Mean	2.1	0.8	1.9	5.5

APPENDIX H6

Analytical Results for Vegetable and Garden Soil

ANALYTICAL RESULTS FOR VEGETABLES AND GARDEN SOIL

Sample Type	Concentration (ppm)							
	Q	Arsenic	Q	Cadmium	Q	Lead	Q	Zinc
Mint	U	1.0	U	0.50	U	5.0		15.5
Potato	U	1.0	U	0.50	U	5.0		4.3
Co-located Garden Soil		4.3	U	0.54		40.3		62.9
Yard Soil (Mean)		710	U	290		690		149

Collected at Residence J.

APPENDIX H7

Mean Concentration Measurements in Yard Soil

MEAN CONCENTRATION MEASUREMENTS IN YARD SOIL

Residence Code	Mean As (ppm)	Mean Cd (ppm)	Mean Pb (ppm)	Mean Zn (ppm)
A	2267	290	1700	700
B	500	290	174	310
C	204	290	342	312
D	365	290	460	220
E	500	290	560	235
F	770	290	835	325
G	307	290	259	196
H	510	290	403	317
I	705	290	1600	515
J	710	290	690	240
K	209	290	133	149
L	1400	290	680	710
N	570	290	300	250
O	720	290	430	325
P	291	290	149	335
Q	325	290	155	235

* Concentration values are the mean of the 5-point composites collected in the Phase II Sampling Event (Summer 1998).

APPENDIX H8

Risk Based Biomonitoring Analytical Results

Analytical Results for Biomonitoring

Residence Code	Race	Gender	Age (yrs)	Collection Date	Collection Time	Date Recieved	Date Reported	ug As/g (hair)	Reporting Limit ug As/g (hair)	ug Pb/dL (blood)	Reporting Limit ug Pb/dL (blood)	mg creatinine/L (urine)	ug As/L (urine)	Reporting Limit ug As/L (urine)	ug As/g creatinine (urine)	Reporting Limit ug As/g creatinine (urine)	specific gravity
A-1	Hispanic	F	58	10/20/1998	1130	10/23/1998	10/30/1998	ND	**0.32**	3		160	ND	**20**	ND	**135**	1.004
A-2	Hispanic	M	56	10/20/1998	1130	10/23/1998	10/30/1998	ND	**0.26**	4		224	ND	**20**	ND	**89.2**	NA
E-1	Hispanic	M	51	10/20/1998	730	10/23/1998	10/30/1998	ND	**0.41**	3		397	ND	**20**	ND	**50.4**	NA
E-2	Hispanic	F	47	10/23/1998	1746	10/27/1998	10/30/1998	ND	**1.16**	2		1294	ND	**20**	ND	**15**	NA
E-3	Hispanic	M	7	10/23/1998	1750	10/27/1998	10/30/1998	ND	**1.32**	2		906	ND	**20**	ND	**22**	NA
E-4	Hispanic	F	3	10/23/1998	1755	10/27/1998	10/30/1998	ND	**0.43**	2		564	ND	**20**	ND	**35**	NA
J-1	NA	F	70	10/22/1998	1045	10/23/1998	10/30/1998	ND	**0.38**	2		267	ND	**20**	ND	**65**	NA
L-1	White	M	65	10/28/1998	NA	10/31/1998	11/05/1998	ND	**0.91**	2		1698	ND	**20**	ND	**11.8**	NA
O-1**	Hispanic	F	43	11/03/1998	1805	11/07/1998	11/12/1998	ND	**0.28**			1339	ND	**20**	ND	**15**	NA
O-1**	Hispanic	F	43	11/06/1998	1710	11/12/1998	11/12/1998			3							NA
O-2**	Hispanic	F	9	11/03/1998	1810	11/07/1998	11/12/1998	ND	**0.39**			239	ND	**20**	ND	**83.6**	NA
O-2**	Hispanic	F	9	11/06/1998	1725	11/12/1998	11/12/1998			2							NA
O-3	Hispanic	F	22	11/03/1998	1818	11/10/1998	11/17/1998	0.41		1		657	ND	**10**	ND	**15.2**	NA
O-4	Hispanic	M	17	11/03/1998	1829	11/06/1998	11/17/1998	ND	**0.45**	2		1399	ND	**10**	ND	**7.1**	NA
O-5	Hispanic	F	13	11/03/1998	1812	11/06/1998	11/17/1998	ND	**0.39**	2		1719	ND	**10**	ND	**5.8**	NA
P-1	Indian	F	16	10/28/1998	1645	10/31/1998	11/05/1998	ND	**0.3**	ND	**1.0**	1520	ND	**20**	ND	**13.2**	NA
P-2	Indian	F	43	10/28/1998	1715	10/31/1998	11/05/1998	ND	**0.29**	2		424	ND	**10**	ND	**47.2**	NA

ND = None Detected
NA = Not Available
** Blood samples were taken on 11/6/98, separately from hair and urine on 11/3/98

APPENDIX I

Phase III Maximum Theoretical Arsenic Hot Spot Concentration Analysis

Maximum Theoretical Arsenic Hot Spot Concentration Analysis

Results in mg/kg

Arsenic MTHC	Composite Samples		Grab Samples	
	Max Conc.	95% UCL	Max Conc.	Mean
1570	172	208	89	51
1570	172	176	1118	316
1560	171	199	165	109
1560	171	196	221	93
1550	170	188	130	97
1550	170	208	469	136
1530	168	218	579	156
1530	168	196	429	87
1520	167	194	298	240
1510	166	190	166	117
1510	166	187	149	90
1500	165	185	488	150
1500	165	190	904	182
1500	165	172	395	154
1490	164	193	335	127
1490	164	191	288	100
1490	164	186	283	188
1480	163	199	699	102
1480	163	183	509	89
1480	163	203	453	113
1450	160	172	210	120
1450	160	168	445	182
1450	160	166	294	144
1440	159	216	227	105
1430	158	188	92	68
1430	158	179	333	141
1430	158	201	279	106
1420	157	213	24	14
1420	157	185	486	105
1410	156	166	343	150
1410	156	169	543	125
1390	154	175	254	91
1380	153	174	344	116
1380	153	176	235	118
1360	151	159	244	116
1360	151	178	1135	276
1360	151	168	225	98
1350	150	175	179	115
1350	150	186	146	94
1350	150	162	396	126
1350	150	173	230	115
1340	149	189	271	177
1340	149	179	253	58
1340	149	182	354	180
1340	149	159	221	102

Maximum Theoretical Arsenic Hot Spot Concentration Analysis				
Results in mg/kg				
Arsenic MTHC	Composite Samples		Grab Samples	
	Max Conc.	95% UCL	Max Conc.	Mean
1330	148	164	657	303
1330	148	156	324	90
1330	148	179	45	35
1320	147	183	237	92
1320	147	179	60	36
1320	147	179	742	128
1310	146	170	866	109
1300	145	174	110	59
1300	145	156	165	102
1290	144	147	529	126
1290	144	179	447	94
1280	143	150	431	145
1280	143	181	910	367
1260	141	175	309	127
1260	141	155	1011	203
1260	141	170	126	57
1250	140	162	916	146
1250	140	164	198	108
1250	140	167	176	67
1240	139	149	275	141
1230	138	153	545	191
1230	138	142	135	59
1230	138	158	297	120
1220	137	144	181	91
1220	137	164	568	171
1220	137	193	104	41
1210	136	140	272	166
1210	136	144	198	122
1210	136	171	96	32
1210	136	154	88	46
1200	135	170	810	199
1200	135	168	312	165
1190	134	146	85	40
1190	134	150	212	102
1180	133	137	29	15
1170	132	156	129	76
1170	132	155	206	145
1170	132	140	579	197
1160	131	153	298	135
1160	131	158	773	103
1160	131	163	1492	122
1140	129	147	84	51
1140	129	144	410	141
1140	129	143	163	117
1120	127	153	224	78

Maximum Theoretical Arsenic Hot Spot Concentration Analysis				
Results in mg/kg				
Arsenic MTHC	Composite Samples		Grab Samples	
	Max Conc.	95% UCL	Max Conc.	Mean
1120	127	133	695	237
1110	126	139	338	105
1110	126	148	346	106
1110	126	138	368	115
1100	125	134	371	191
1100	125	137	273	65
1090	124	149	256	54
1090	124	139	272	113
1090	124	159	36	25
1080	123	131	199	45
1070	122	140	980	176
1070	122	133	639	242
1060	121	149	302	49
1060	121	142	86	28
1050	120	142	198	53
1050	120	135	46	24
1050	120	127	203	103
1050	120	150	216	120
1040	119	129	346	117
1040	119	139	323	110
1040	119	139	223	69
1030	118	135	221	54
1030	118	139	1439	189
1020	117	146	58	35
1020	117	128	611	237
1020	117	144	225	93
1020	117	132	552	62
1010	116	128	479	163
1010	116	149	169	42

APPENDIX J

Garden Soil and Garden Vegetable Data

GARDEN VEGETABLE AND SOIL DATA

Property ID	Garden Vegetables								Garden Soils				Yard Soils	
	Vegetable Type	Dry Wt. Conc (mg/kg dw)				% Solid	Wet Wt. Conc (mg/kg ww)		As		Pb		As Mean	Pb Mean
		As		Pb			As	Pb						
1	Rhubarb	0.05	U	0.61		8.70	4.35E-03	5.31E-02	11	U	123		<11	180
1	Chard	0.10	J	0.57		6.52	6.52E-03	3.72E-02	11	U	110			
1	Peppers	0.05	U	0.11	J	10.60	5.30E-03	1.17E-02	11	U	152			
1	Squash	0.06	J	0.20		3.64	2.18E-03	7.28E-03	15		249			
1	Squash	0.05	U	0.05	U	13.70	6.85E-03	6.85E-03	11	U	101			
1	Eggplant	0.08	J	0.05	U	10.10	8.08E-03	5.05E-03	11	U	127			
1	Cabbage	0.05	U	0.05	U	10.10	5.05E-03	5.05E-03	11	U	111			
1	Cauliflower	0.05	U	0.05	U	9.98	4.99E-03	4.99E-03	11	U	101			
1	Tomatoes	0.05	U	0.05	U	7.71	3.86E-03	3.86E-03	11	U	105			
1	Squash	0.05	U	0.07	J	4.26	2.13E-03	2.98E-03	11	U	223			
2	Tomatillo	0.05	U	0.05	U	16.50	8.25E-03	8.25E-03	11	U	114		<11	94
3	Collard Greens	0.34		0.24		12.90	4.39E-02	3.10E-02	11	U	96		54	237
4	Lettuce	0.10	J	2.20		10.50	1.05E-02	2.31E-01	12		128		<11	127
4	Carrots	0.06	J	0.96		13.20	7.92E-03	1.27E-01	11	U	119			
4	Beets	0.05	U	0.94		12.70	6.35E-03	1.19E-01	11		130			
4	Turnip Greens	0.08	J	0.68		13.60	1.09E-02	9.25E-02	11		130			
4	Rutabaga	0.17		0.80		11.40	1.94E-02	9.12E-02	11	U	116			
4	Collard Greens	0.32		0.20		17.10	5.47E-02	3.42E-02	11	U	116			
5	Collard Greens	0.16		0.50		12.10	1.94E-02	6.05E-02	11	U	52	U	<11	90
5	Peppers	0.05	U	0.05	U	15.00	7.50E-03	7.50E-03	12		87			
6	Onions	6.30		1.78		15.60	9.83E-01	2.78E-01	73		146		129	211
6	Carrots	0.50		1.34		13.10	6.55E-02	1.76E-01	47	J	104	J		
6	Beets	1.09		1.13		13.90	1.52E-01	1.57E-01	55		98			
6	Turnips	3.45		1.21		6.11	2.11E-01	7.39E-02	40		90			
6	Cauliflower	0.46		0.50		10.00	4.60E-02	5.00E-02	93		124			
6	Collard Greens	0.37		0.12	J	15.50	5.74E-02	1.86E-02	57		140			
6	Collard Greens	0.63		0.11	J	16.20	1.02E-01	1.78E-02	43		132			
6	Cucumbers	2.92		0.27		5.92	1.73E-01	1.60E-02	69		172			
6	Zucchini	1.63		0.11	J	9.54	1.56E-01	1.05E-02	45		280			
6	Squash	0.63		0.08	J	9.70	6.11E-02	7.76E-03	46		137			
6	Tomatoes	0.08	J	0.05	U	13.30	1.06E-02	6.65E-03	25		139			
6	Cabbage	0.31		0.05	U	9.95	3.08E-02	4.98E-03	48		110			
7	Cabbage	0.08	J	0.08	J	19.90	1.59E-02	1.59E-02	11	U	66		106	129
7	Tomatillo	0.05	U	0.06	J	16.30	8.15E-03	9.78E-03	11	U	57			
8	Beets	0.34		2.32		19.70	6.70E-02	4.57E-01	11	U	236		22	225
8	Turnips	0.52		0.98		7.29	3.79E-02	7.14E-02	20		261			

Property ID	Garden Vegetables								Garden Soils				Yard Soils	
	Vegetable Type	Dry Wt. Conc (mg/kg dw)				% Solid	Wet Wt. Conc (mg/kg ww)		As		Pb		As Mean	Pb Mean
		As		Pb			As	Pb						
9	Tomatoes	0.05	U	0.05	U	7.07	3.54E-03	3.54E-03	11	U	137		91	208
9	Tomatoes	0.05	U	0.05	U	6.54	3.27E-03	3.27E-03	37		171			
10	Tomatoes	0.05	U	0.62		7.67	3.84E-03	4.76E-02	18		314		11	308
11	Garlic*	1.24		38.60		16.50	2.05E-01	6.37E+00	11	U	271		25	256
11	Chard	0.14	J	4.31		13.20	1.85E-02	5.69E-01	12		148			
11	Onions	0.10	J	1.67		12.40	1.24E-02	2.07E-01	11	U	250			
11	Collard Greens	0.07	J	0.53		13.80	9.66E-03	7.31E-02	18		185			
11	Collard Greens	0.12	J	0.16		13.60	1.63E-02	2.18E-02	16		213			
11	Cucumbers	0.67		0.18		6.02	4.03E-02	1.08E-02	17		259			
12	Carrots	0.27		1.15		11.00	2.97E-02	1.27E-01	26		140		69	259
12	Collard Greens	0.38		0.58		12.00	4.56E-02	6.96E-02	18		225			
12	Collard Greens	0.56		0.30		13.00	7.28E-02	3.90E-02	23		157			
12	Collard Greens	0.27		0.29		11.00	2.97E-02	3.19E-02	25		152			
13	Onions	0.17		1.87		14.80	2.52E-02	2.77E-01	17		218		>11	176
13	Celery	0.19		2.05		8.25	1.57E-02	1.69E-01	11	U	339			
13	Turnips	0.33		1.57		10.20	3.37E-02	1.60E-01	11	U	210			
13	Collard Greens	0.11	J	0.16		13.70	1.51E-02	2.19E-02	25		344			
13	Squash	0.05	J	0.29		6.17	3.09E-03	1.79E-02	11	U	241			
13	Peas	0.05	U	0.06	J	22.50	1.13E-02	1.35E-02	11	U	294			
13	Cabbage	0.13	J	0.05	U	11.60	1.51E-02	5.80E-03	12		186			
13	Tomatoes	0.05	U	0.05	U	9.96	4.98E-03	4.98E-03	11	U	253			
13	Cabbage	0.05	U	0.05	U	9.24	4.62E-03	4.62E-03	11	U	196			
14	Onions	0.14	J	0.68		13.80	1.93E-02	9.38E-02	12		162		381	477
14	Peppers	0.05	U	0.20		9.68	4.84E-03	1.94E-02	15		172			
14	Broccoli	0.08	J	0.06	J	12.20	9.76E-03	7.32E-03	21		184			
15	Cucumbers	0.68		0.66		4.55	3.09E-02	3.00E-02	11	U	369		21	513
15	Tomatoes	0.05	U	0.33		5.84	2.92E-03	1.93E-02	11	U	570			
15	Tomatillo	0.10	J	0.16		7.37	7.37E-03	1.18E-02	11	U	335			
15	Tomatoes	0.05	U	0.10	J	6.63	3.32E-03	6.63E-03	11	U	381			
16	Peppers	0.15		0.15	J	13.10	1.97E-02	1.97E-02	15		80		124	399
17	Tomatoes	0.05	U	0.18		5.90	2.95E-03	1.06E-02	11	U	52	U	147	389
17	Peppers	0.05	U	0.05	U	13.60	6.80E-03	6.80E-03	11	U	61			
18	Tomatoes	0.05	U	0.11	J	5.77	2.89E-03	6.35E-03	14		573		139	579
19	Beans	0.05	U	0.13	J	19.00	9.50E-03	2.47E-02	11	U	408		12	317
19	Tomatillo	0.05	U	0.20		6.47	3.24E-03	1.29E-02	16		236			
19	Tomatoes	0.05	U	0.05	U	6.05	3.03E-03	3.03E-03	11	U	261			

U: Not detected
J: Estimated value
*: Garlic from Property 11 was later re-sampled: As=0.20 mg/kg, Pb=3.21 mg/kg (dry weight)

APPENDIX K

Public Meeting Flyers

A Superfund Site in Your Neighborhood?

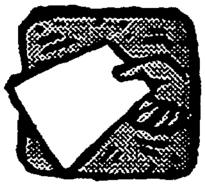
(Clayton, Cole, Elyria, Swansea, and Globeville)

Come to a public information session.

Wednesday, March 10, 1999 at 6:30 p.m.
Swansea Recreation Center
2650 East 49th Avenue

Learn how an area gets proposed for Superfund.

Find out what kind of information is in the Superfund proposal.



Find out how to comment on the information used to support Superfund status on areas in northeast Denver.

Staff from the Environmental Protection Agency (EPA) will answer questions and present information on the comment process.

VB I-70

Fact Sheet

Why is the EPA in Cole & Clayton?

Fact Sheet
Number 3
June 1999

What is the EPA?

The United States Environmental Protection Agency (EPA) was created by Congress in 1970 to protect human health and the environment.

What has the EPA done in Cole and Clayton?

The EPA began sampling soil near smelter sites to the north in Globeville, Elyria, and Swansea. The sampling expanded south into Cole and Clayton when no clear boundaries were found to the contamination. In the spring of 1998, sampling reached as far south as 38th Street. That summer a smaller sampling effort included some properties down to 35th Street.

What has soil sampling found in Cole and Clayton?

Soil sampling has shown arsenic and lead in some residential yards. The majority of yards sampled have low levels, but the EPA is studying the potential health risks of these metals in the neighborhoods.

Is there really a problem in Cole and Clayton?

Most of those yards sampled showed low levels of metals. Still, there is not a clear pattern to where higher levels are found. The EPA needs to sample more properties in Cole and Clayton. So far, around 186 properties in Cole and 189 in Clayton have been sampled. The EPA found contamination high enough at 1 property in Cole and 3 in Clayton to require an immediate cleanup. These 4 cleanups were completed in November 1998. As more sampling is done and the health risks are studied, the EPA will better understand the problem.

Information is publically available at the Ford Warren Library

2825 High Street, Denver, CO 80205
Tel: (303) 294-0907
Hours: M & Th 10:30 am -5:00 PM
T & W 10:30 AM - 9:00 PM
Sat. 10:30 AM - 4:30 PM

Public Meeting

Come to a public meeting on soil sampling in Cole and Clayton.

When: June 22, 1999, 7:00 PM
Where: Harrington Elementary
2401 East 37th Avenue

What additional sampling is planned?

The EPA plans to sample all residential properties in Cole and Clayton this summer.

Why should I get my property sampled?

Soil sampling is the only way to find out if your property has soil contaminated with metals. The EPA is studying the health risks of these metals to determine if cleanup will be necessary. Sampling is a free service for property owners.

Why has my neighborhood been proposed as a Superfund site?

On January 19, 1999, this area, along with other neighborhoods, was proposed to the Superfund National Priorities List. This is a list of contaminated sites that are eligible for cleanup funding under the Superfund program.

For More Information Please Contact:

Ted Fellman (EPA) at (303) 312-6119;
Pat Courtney (EPA) at (303) 312-6631;
Bonnie Lavelle (EPA) at (303) 312-6579;
Barbara O'Grady (CDPHE) at (303) 692-3395; or
Marion Galant (CDPHE) at (303) 692-3304.

VB I-70

Fact Sheet

Fact Sheet Number 4
September 1999

OPEN HOUSE:
Learn More About Risk Assessment

The job of the U.S. Environmental Protection Agency (EPA) is to protect public health and the environment. The EPA has found arsenic and lead in the soil of some yards in the Swansea, Elyria, Cole, Clayton, and South Globeville neighborhoods. The EPA is currently studying the health risks of this contamination. This process is called **risk assessment**. The risk assessment is important because it will help determine what action, if any, needs to be taken to address the contamination in these neighborhoods.

Can these metals be harmful to you and your family? The EPA's risk assessment will help answer this question. The first step to understand the health risks is to determine how people come into contact with contaminated soil. In discussions with other agencies and community members, the EPA has outlined a number of ways that people come into contact with the soil. Things like:

- ✓ Children playing in their yards.
- ✓ Pets bringing in dirt from outside.
- ✓ Children playing in empty lots, dirt alleys, along railroad tracks.
- ✓ People eating vegetables from home gardens.
- ✓ People touching or breathing dust while in their homes or outside.
- ✓ Construction workers breathing or accidently swallowing dirt while digging.

This does not mean that all of these activities are harmful. But the EPA will study all of them in order to evaluate the risks you may face in your neighborhood.

Can you think of other ways that people in your neighborhood come into contact with the soil? Come to one of the open houses to share what you know about your neighborhood and help guide this important study.

We want to hear from YOU!

Please drop in anytime between 4:00-8:00 PM to the EPA's risk assessment open house in your neighborhood. The open house is an opportunity to learn more about this important study, ask questions, and share your views on these issues. There will be no formal presentation, but displays and fact sheets will present information about the risk assessment in your neighborhood. Staff will be there to answer your questions.

OPEN HOUSES

Swansea Recreation Center
Wednesday
September 22, 1999
4:00-8:00 PM
2650 East 49th Avenue

Harrington Elementary
Tuesday
September 28, 1999
4:00-8:00 PM
2401 East 37th Avenue

For More Information Please Contact:

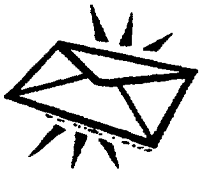
U.S. Environmental Protection Agency:

Ted Fellman at (303) 312-6119;
Pat Courtney at (303) 312-6631; or
Bonnie Lavelle at (303) 312-6579.

Colorado Department of Public Health and Environment:

Barbara O'Grady at (303) 692-3395; or
Marion Galant at (303) 692-3304.

Soil Sampling Results are Here!



Results from last fall's soil sampling have been mailed to homeowners. The EPA (Environmental Protection Agency) will be hosting public meetings this February to answer questions about results and talk about additional sampling. We hope you can come.

What does this mean to you?

- Find out about the soil sampling results.
- Learn what will happen next.
- Ask questions about sampling and cleanup.

Please come find out more.

Tuesday, February 22 2000
6:30-8:30 PM
Harrington Elementary
2401 East 37th Avenue

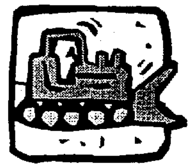
Wednesday, February 23 2000
6:30-8:30 PM
Swansea Recreation Center
2650 East 49th Avenue

For more information or to find out how to get your soil sampled, call:
Ted Fellman, at (303) 312-6119 or
Pat Courtney, at (303) 312-6631.

Now that my yard has been sampled, what happens next?

When will cleanup begin, and where?

Do I have a say in the cleanup of my yard?



Can I eat vegetables from my garden?

Can my children play safely in our backyard?

Get the facts about soil cleanups

in the Swansea, Elyria, Cole, and Clayton neighborhoods.
Come to a public meeting...

Tuesday, September 26 at 6:30 PM
Harrington Elementary School
2401 East 37th Avenue

Wednesday, September 27 at 6:30 PM
Swansea Recreation Center
2650 East 49th Avenue

Call (303) 312-6119 for more information
or to set up another meeting with your neighborhood group.